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JULY

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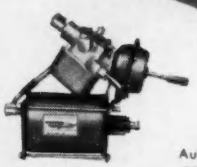
Bendix Products

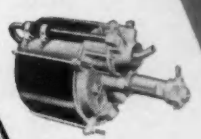
KEEPING BRAKES IN STEP WITH MODERN NEEDS

Centermount Emergency and Parking Brake for Buses and Trucks

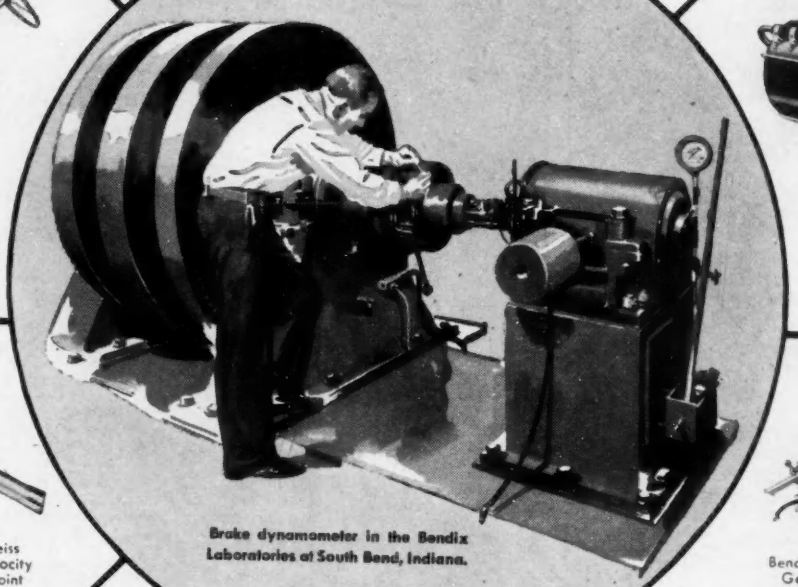


Bendix* Automatic Clutch and Gear Shift Control Systems

Bendix Hydraulic Power Steering Gear

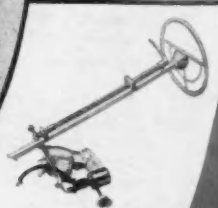


Hydrovac* Power Brake for all types of trucks

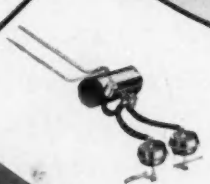


Brake dynamometer in the Bendix Laboratories at South Bend, Indiana.

Bendix-Weiss Constant Velocity Universal Joint



Bendix Vacuum Power Gear Shift Assistor



B-K* Power Braking System for Trucks and Trailers

BENDIX* BRAKES

Standard of Safety Wherever Wheels Turn

For over 20 years Bendix research has been making automotive brakes smoother, safer, and easier to operate. For example, in the Bendix Duo-Servo* Brake the friction of one brake shoe "serves" a second shoe against the drum. The result is a remarkably effective brake that needs only a light pedal pressure. This type of creative engineering, plus mass production know-how, has made Bendix Brakes the standard of safety wherever wheels turn.

A new booklet, "Bendix Duo-Servo Brakes", describes this interesting brake principle. Send for your free copy.

*REG. U. S. PAT. OFF.

BENDIX TROPHY RACE SEPTEMBER 6

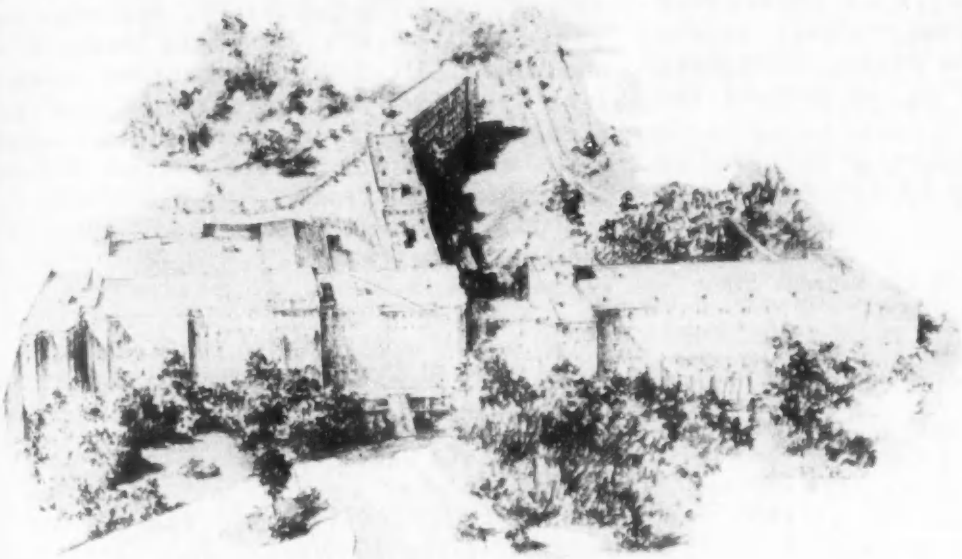
BENDIX PRODUCTS

DIVISION of Bendix AVIATION CORPORATION

SOUTH BEND 20, INDIANA

NEW PRODUCT "WHYS & WHATS"

Revealed at French Lick Summer Meeting Sessions



A two-flanked gain in fuel economy and conservation was proposed by developers of water-alcohol injection and dual-fuel systems for motor vehicles. Fuel and engine men were told how these developments could satisfy the engine's thirst for high antiknock quality, speed use of high compression ratio engines, without calling for greater octane number step-up from the refinery.

MORE than 1100 members and guests learned the "why" as well as the "what" about new cars, trucks, buses, and engines at the 1948 SAE Summer Meeting at French Lick Springs, June 6-11. Top-flight designers of a dozen outstanding new ground vehicle units spoke frankly about problems encountered in completing their new designs, answered questions posed by both young and veteran confreres, and exchanged data in sessions and informal conferences. Better performance for less cost was a dominant theme of their attack. Materials, fuels, styling, lessons from military experience, and highway influence on design were all probed in the drive of the French Lick speakers toward the better-performance-less-cost end.

They also cooperatively attacked some joint problems that new refinery methods are bringing.

Meat for aeronautic men was served up in sessions dealing with research results in the turboprop and turbojet areas - and in a top-secret session where Army men revealed details of experience in cold-weather operation.

A "Big Family Dinner Party" opened the meeting on Sunday evening with Indianapolis Speedway President Wilbur Shaw telling personal experiences with men and

CONTINUED ON PAGE 62

SUMMARY OF PAPER* BY

Robert E. Wilson

Chairman of the Board

Standard Oil Co. (Ind.)

SUPPLYING The M

IN an effort to help meet the record demand for petroleum products, the oil industry has achieved a greater expansion program than any major group of industries in the United States since 1941.

To have come within 2% of having met the demand for petroleum products in the Middle-West during the winter just past is a major achievement on the part of the oil industry.

How great the problem faced by the industry was is shown by the following table:

Increase in Consumption in the Midwest Since 1941 and 1946

Product	*1947 over 1941 per cent increase*	*1947 over 1946 per cent increase*
Gasoline	18.8	8.7
Kerosene	115.5	38.8
Distillate fuels	62.6	23.6
Residual fuel	34.6	24.0
Others	30.0	11.8
Total	31.0	14.0

The increase in Middle-West consumption, though slightly below the nationwide average for 1947 over 1941, was above the nationwide average in comparison of 1947 and 1946.

The reason for the increase in demand was primarily the pronounced development in use of all types of oil-consuming devices and equipment. Passenger cars are now somewhat more numerous than they were before and during the war. Buses and trucks are much more numerous, and all types of automotive vehicles are being driven more miles per year. Railroads are rapidly dieselizing their locomotive equipment. Of 2100 locomotives ordered last year, 96% were diesels. Commercial airplanes are flying larger planes more miles than in the prewar period, and the peacetime operations of military aircraft are far more extensive than in earlier periods of peace.

MORE OIL BURNERS USED

The growth has been particularly noticeable, however, in the case of both oil burners for central heating and space heaters using kerosene. Oil burner installations in 1947 totaled 830,000 throughout the nation, which was approximately five times the prewar average of annual installations.

While this kind of postwar demand was building up in the Midwest, that area was still having to overcome some special handicaps as to supplies. There was little refinery construction in the Midwest during the war. Such construction was sharply limited by government regulations except at coastal points where products could be readily available for shipment abroad by water. Likewise, there was little construction of additional pipe lines into the Midwest, which is practically dependent on that form of transportation for its supply of crude oil.

While construction was stagnant during the war, crude oil production in the area was declining. Due to gradual exhaustion

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*Paper "Supplying the Midwest with Petroleum Products" was presented at the SAE National Passenger Car & Production Meeting, Detroit, March 5, 1948.... *A previous brief summary of Dr. Wilson's address (April, 1948 SAE Journal, p. 19) contained several errors and misinterpreted the author's meaning.*

MIDWEST With PETROLEUM PRODUCTS

of the Michigan and Illinois oil fields, there has been a drop of 250,000 bbl. a day in Midwest crude production as against that prevailing in the latter part of 1941.

Because of these handicaps the Midwest was the first area to feel the pinch with respect to petroleum products and to take steps to overcome it. As a result it went into the winter somewhat better prepared, and is now better off in regard to heating oil supplies then the East coast, though the situation is still tight.

The winter's experience demonstrated that it is impossible to heat the homes of all America with oil and meet other pressing demands for petroleum products. While it is not for the supplying industry, which believes in a free economy, to say what class of customers shall benefit from its products, there is a simple position it can take. That position, and the one adopted by Standard Oil Co. (Ind.), is to advise the public, including all potential purchasers of oil burners, of the facts about prospective oil supplies. Many companies have reached the limit in the number of fuel oil customers they can take on.

In explaining how oil supplies have been stepped up to an unprecedented degree in spite of many difficulties, a description of the operations of Standard of Indiana is a good example because its marketing operations are primarily in the Middle-West.

Standard of Indiana's subsidiaries produced in 1947 agross of nearly 84,000,000 bbl. of crude and discovered more than this amount of new reserves. Several thousand people were intensively engaged in exploration, leasing, and drilling to accomplish this result. In 1947 the subsidiaries drilled over 800 wells, about 70 of which were wildcats, costing an average of about $200,000 each. Of the wildcats nearly 70% proved to be dry holes. The average of such failures for the industry was 80%.

Imagine what would happen if wildcatting for oil were under government control! No bureaucrat would dare take risks involving the certainty that 70 to 80% of his attempts to find new oil reserves would be failures. Experience in Mexico since expropriation of American companies' properties has shown how unsuccessful government operation of exploration for oil can be.

PRODUCED 84 MILLION BBL.

Standard Oil Co. (Ind.) subsidiaries are now producing about two and a half times as much crude as they were in 1940, but this covers only a little over half of the present refinery requirements of the consolidated company. About 8000 wells are required to yield this production. Other subsidiaries are operating 14,000 miles of truck pipe lines, but the company is having to use expensive tank car shipments at a rate of about 15,000 bbl. a day to supplement pipe line deliveries.

The company distributes products by tank cars, lake tankers, transport trucks, and barges throughout the Middle-West. With its marketing subsidiaries, it operates some 4500 bulk supply plants that furnish products to 31,000 dealer stations as well as direct to farmers and quantity consumers. The dealer stations are all independently operated by small business men, the company operating only a small number of stations primarily for training purposes.

In its effort to improve processes and

products so as to get utmost value out of crude oil, Standard of Indiana and its subsidiaries are spending about $9,000,000 a year on research activities. One major current development is in the field of production of gasoline synthetically from natural gas. Stanolind Oil and Gas Co. is at present proceeding with plans for a large plant at Garden City, Kans., to manufacture gasoline from the enormous gas reserves available in the Hugoton field.

Except for this development, the petroleum industry is not quite ready for synthetic production of oil. Increased research is desirable in the field of manufacture of oil from coal, but public funds should not be used for a reckless venture into large-scale production.

Looking forward, it appears that, barring accidents, there will be an increase of about 7 or 8% in the production of petroleum products in this country in 1948. To achieve this, the oil industry will spend about $3,000,000,000 in new facilities, as expansion is necessary all along the line from the oil well to the consumer. This expansion will represent a major accomplishment in time of shortage of many construction materials. Part of this increased production will have to go to replace depleted stocks, fill up new pipe lines and terminals, and so forth, but 5 or 6% more products should be available for domestic consumption than in 1948. However, in the case of fuel oil most of this increase will be needed to take care of burners which were installed since last summer and handling increased military requirements for jet fuels, and so forth.

The one sure way to have and perpetuate shortages, rationing, and other problems would be to let the government take advantage of the very moderate difficulties that have so far been experienced to take control. Government control would ruin incentives, tie the industry up in red tape, and bring about reductions in output and permanent shortages instead of the remarkable gains the oil industry is recording through the give and take of competition to solve its problems.

The real hope of the future is in research, technology, and free enterprise, which can and will solve the problem if they are allowed the chance which their past record shows they clearly merit.

SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
WEST COAST	Aug. 18-20	St. Francis, San Francisco
TRACTOR and DIESEL ENGINE	Sept. 7-9	Schroeder, Milwaukee
AERONAUTIC and AIRCRAFT Engineering Display	Oct. 6-9	Biltmore, Los Angeles
PRODUCTION MEETING and CLINIC	Oct. 21-22	Statler, Cleveland
FUELS and LUBRICANTS	Nov. 4-5	Mayo, Tulsa
	• 1949	
ANNUAL MEETING and Engineering Display	Jan. 10-14	Book-Cadillac, Detroit
PASSENGER CAR	March 9-11	Book-Cadillac, Detroit
TRANSPORTATION	March 28-30	Statler, Cleveland
AERONAUTIC and AIR TRANSPORT	April 11-13	New Yorker, New York

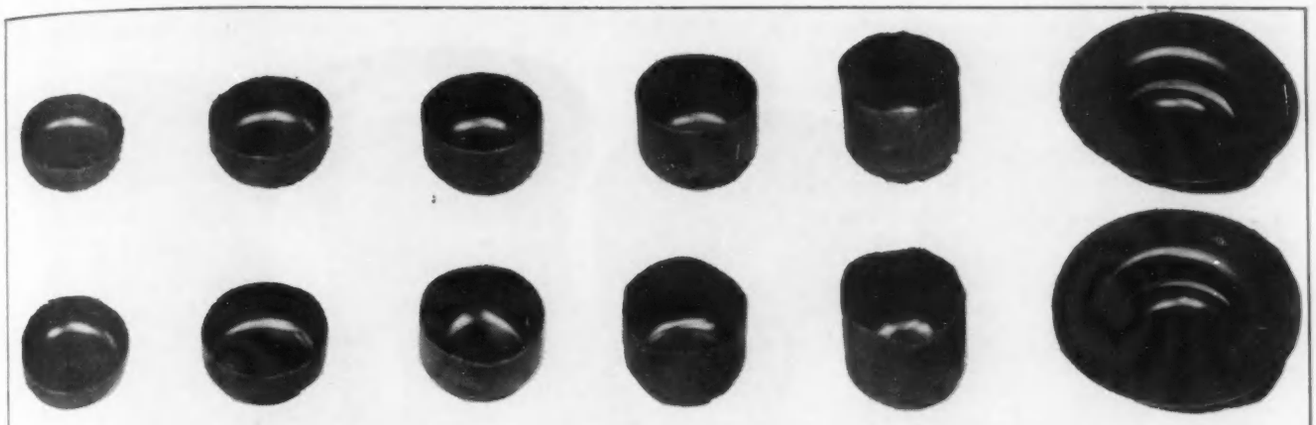


Fig. 1 - One-operation draws from successively larger blanks. Top row from low alloy high tensile, bottom row from deep drawing steel. Blank diameters, both rows, left to right, 4, 4.5, 5, 5.5, 6, 6.5 in. Draw ring diameter 3 in. and punch diameter 2.88 in. were used in all draws. Punch loads ranged from 8750 to 37,000 lb for the HT blanks and from 5500 to 26,200 DD blanks in lower row

Low Alloy High Tensile Steels

BASED ON PAPER* BY

C. L. Altenburger

Research Engineer, Great Lakes Steel Corp.

(This paper will be published in full in SAE Quarterly Transactions)

JUDICIOUS use of low alloy high tensile steels instead of mild carbon steels will enable more products to be made with the available steel tonnage, and will produce parts of greater durability.

Advantages of the newer steels include:

Higher strength, and

Greater resistance to corrosion.

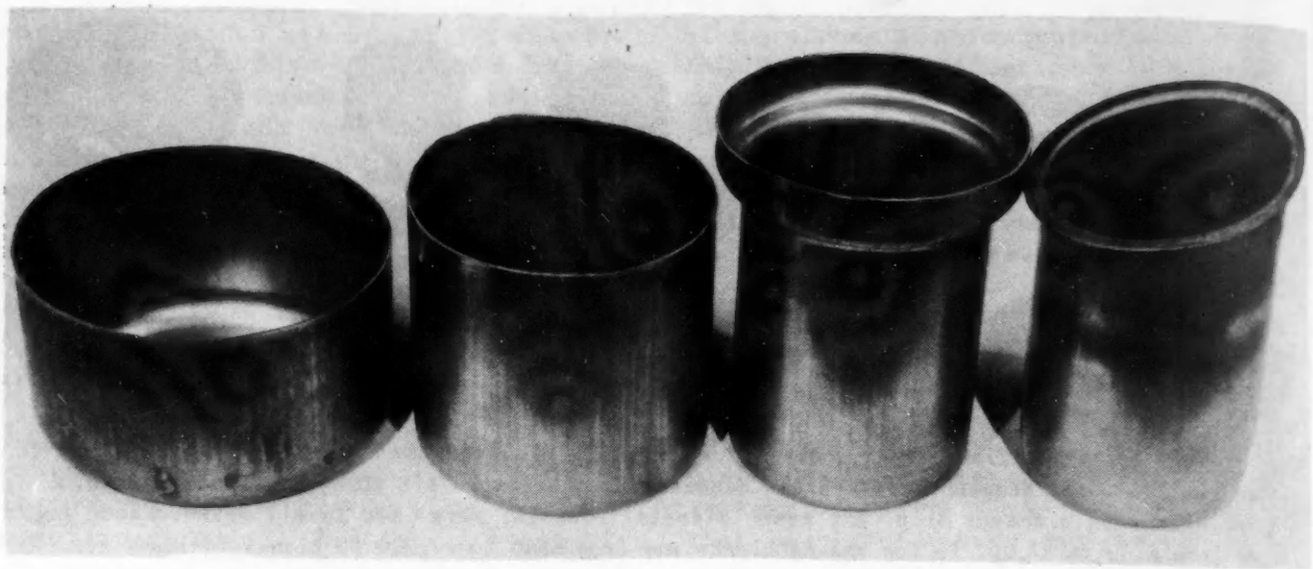
Shop men, die men, engineers, and others who have had long experience with low carbon soft steels should not assume that low carbon knowledge can be applied to the fabrication of the low alloy high tensile steels without modifications.

A carbon steel with a Rockwell of B75 would not have sufficient plasticity to permit forming even a simple fender. However, a low alloy high tensile of the same hardness has been used successfully for several million fenders made with less than 0.5% breakage.

In some types of draws low alloy high tensile of good quality can be drawn as deep as low carbon steels. Reductions of 50% from blank diameter to the shell diameter can be made in one operation when the shell is compression drawn beneath pressure pads. If blank sizes exceed this for flat bottomed shells, the punch will push the bottom out. Where bottoms are rounded with, for example, a spherical nosed punch, these reductions can be exceeded.

By roughening the nose of the punch to

*"Practical Usage of Low Alloy High Tensile Steels in Automotive Structures" was presented at SAE Annual Meeting, Detroit, Jan. 12, 1948.



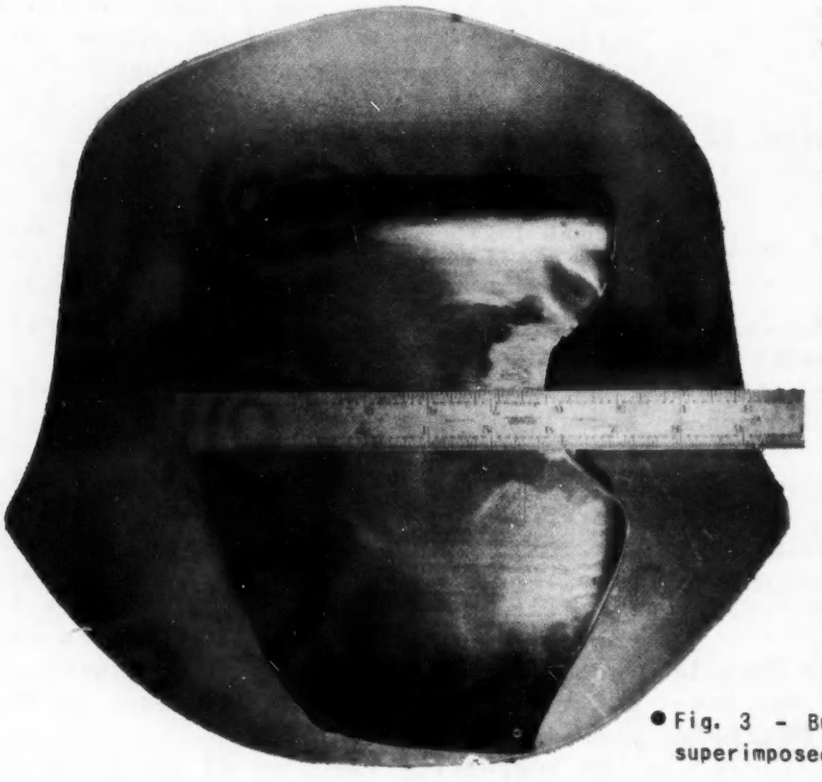
● Fig. 2 - Drawn shells of low alloy high tensile steel produced in four draws

distribute tensile strengths over a greater area, this depth can be exceeded. But extending the depth of draw too far will induce spring back forces which are tensile in compression draws. These are so high that a slight vibration or other externally applied tension will lead to vertical splitting.

A series of vertical drawn shells of different blank diameters at a given punch diameter is shown in Fig. 1. The top row of six was drawn with a round nosed punch and the material was low alloy high tensile steel sheet. The second row was drawn with a flat punch and the same material was used. The bottom row was for a flat nosed punch, and a low carbon deep drawing steel was used. Blank diameters, reading from left to right in each row, are 4, 4.5, 5, 5.5, 6, and 6.5 in.; these were all one-operation draws.

A three operation draw is shown in Fig. 2, and Fig. 3 shows a bumper guard formed in one operation as an example of unsymmetrical compression draw with low alloy high tensile steel.

Ten-inch specimens machined from low alloy high tensile and mild deep drawing steel are shown before pulling, at maximum load, and after fracture in Fig. 4. An attempt to attain these values in a die which has been set up for low carbon steels may lead to failure. Generally, dies must be modified to be used successfully on high tensile steels.



● Fig. 3 - Bumper guard formed in one operation superimposed on its blank

Modifications include:

Increased pad pressure in compression draws to prevent wrinkling,
Allowances for increased spring back,
Probable necessity for using larger radii,
Unless gage is reduced due to the use of high tensile steels, increased pressures are required for forming, and
Draw beads may require modification to hold the high tensile to prevent slippage and buckling.

Bending radii for safe practice is more a matter of experience than predictions. Bendability is greater in narrow widths, due presumably to the greater complexity of stress at the tension surface when bending wide widths.

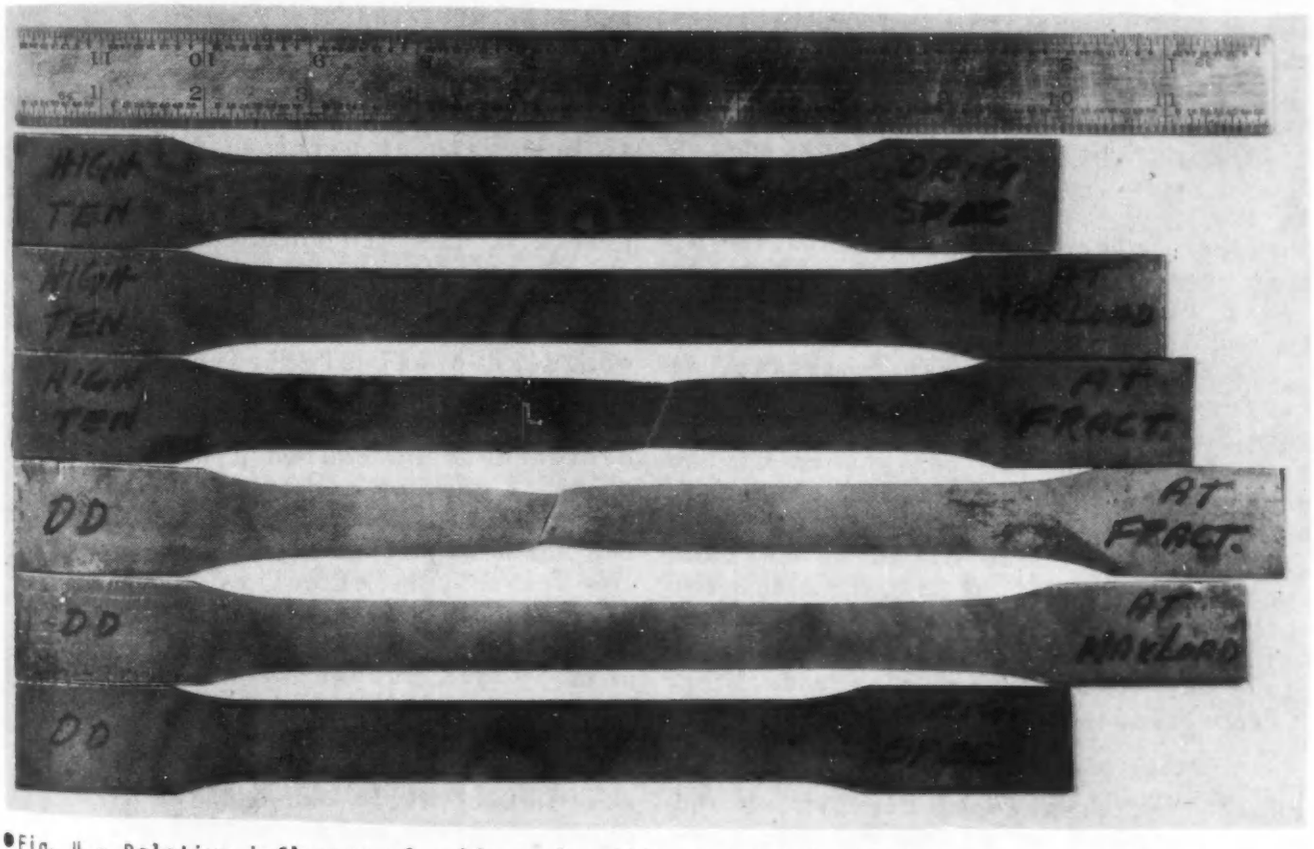
Welding the low alloy high tensile steels presents no great problem, because the same processes are employed as in welding carbon steels. Resistance welding the new steels requires a greater pressure to bring the surfaces of the higher yield strength of the high tensile steel together. Higher current values are also required. Either gas or electrical welding can be used. The welds are generally tough.

The designer has greater opportunity in exercising his skill when designing for low alloy high tensile steel as compared with working with carbon steels. In some, reduction of two gages is possible for approximate equal strength of certain automotive parts.

Where resistance to local denting is the sole desire, the higher strength steels can be used advantageously. Here comparative resistances are proportional to the entire stress strain diagrams. Roughly, the force required to produce a given degree of indentation is proportional to the arithmetic average of yield and tensile strength.

Where resistance to bending is of interest, proportionality to yield strength is an approximate rule.

Complete paper on which this artical is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.



•Fig. 4 - Relative influence of uniform elongation and total elongation on a high tensile steel (upper three) and low carbon deep drawing steel (three samples below)

ELECTRICAL U

BASED ON PAPER* BY
Karl Martinez
Acoustics-Electrical Unit Chief
BOEING AIRPLANE CO.

SPECIAL consideration must be given to electrical equipment installed in airplanes for high-altitude flight, because units that function satisfactorily at low altitudes often operate improperly - or even fail - at 40,000 ft and above, unless specifically designed for this type of operation.

These failures are due to the following differences between the atmosphere at high altitude and the atmosphere at sea level:

1. Lower temperature.
2. Lower air pressure.
3. Extreme dryness.
4. Presence of ozone, ultraviolet rays, ionization, and the like.

Covered here are the effects of the first three items. Data on the last one were not taken for lack of adequate equipment at the time the test program was executed.

EFFECT OF LOW TEMPERATURE

Flights of a B-17G and a B-29 at 40,000 ft for periods ranging from a few minutes to 2-3½ hr brought to light a number of items that failed to operate properly, or not at all, due to the low temperatures encountered (-62 to -94 F).

For instance, several limit-switch plungers operated erratically because different coefficients of expansion caused parts to contract different amounts as the temperature dropped. Adequate physical tolerance was the solution in this case, for the trouble was traced at least in part to the plungers being seized by the sleeves.

The drop in electrical resistance as temperature falls made it harder to parallel generators because this operation depends on the resistance of the equalizing circuit for each generator being as close as possible to a definite value. Since these circuits include conductor runs of 30 ft or so for the outboard engine, the resistance of the circuit dropped appreciably when the plane was flown at high altitudes.

Proper lubricants must be used in all equipment at these low temperatures. For example, on early flights at high altitude, wing flap electric motors became excessively hot, armature and field insulation charred. It was found that the lubricant in the wing flap tracks became so hard that it caused more friction than had been expected, forcing the motors to try to operate at greater than the design load. Substitution of a low-temperature lubricant, which allowed the wing flaps to move without overloading the motor, eliminated this trouble.

EFFECT OF LOW AIR PRESSURE

Offhand, it would appear that the extremely low outside air temperatures would keep all electrical equipment sufficiently cold at high altitudes, but such is not the case with equipment designed to be cooled primarily by an adequate mass of air at a reasonably low temperature flowing around or through the unit. With this type of equipment the low-temperature effect is offset by the decreased air density to such an extent that the total mass of air around the unit is not enough to carry away the heat that is being generated.

This overheating caused a number of difficulties. Brush pigtails melted on some units, while brush boxes melted on others. Silver solder melted on several units at the joint between the armature coil and the commutator bars. Electrical

*Paper 'Performance of Electrical and Radio Equipment at 40,000 Ft' was presented at the SAE National Aeronautic Meeting, New York, April 14, 1948.

UNITS Seen Requiring Special High-Altitude Treatment

insulation in armatures and fields was often scorched during a test run. Wax melted from transformers installed in the chassis of radio receivers and transmitters. Voltage regulators were not satisfactory above 25,000 ft.

It appears that these troubles might be alleviated and generators cooled better by a more open type of construction around the fields and armatures, and by eliminating many of the bends and curves in the inlet blast tube and exhausting air to a negative pressure area as close to the generator as possible. This increases the air pressure drop across the generator and means an additional mass of air to conduct the heat away. Incidentally, the increased cooling would mean that present-day generators and alternators could be rated higher, additional power would thus be supplied with little or no additional weight.

Carbon-pile voltage regulators might be made to give reasonably satisfactory operation at 40,000 ft if more cooling fins were placed around the carbon pile and possibly around the coil end. It is quite possible that the performance of voltage regulators has been jeopardized by attempts to save weight in their design.

Since the mass of air available for cooling at 40,000 ft is so small as to be practically nonexistent, it may eventually be necessary to cool electrical equipment by some form of refrigeration.

The lack of air at high altitudes has a further bad effect in that it often leads to voltage breakdown and arcing. The air normally present around electrical equipment acts as a resistance to prevent arcing, but at 40,000 ft and higher the amount of air is insufficient to prevent this arcing unless this reduced resistance was taken into account when the equipment was designed.

For this reason the electrical plugs used as connectors often burnt out and switches that broke current safely at sea level sometimes severely burnt the contacts and even melted them at high altitudes.

In plugs the voltage breakdown occurred between the pins and the shell along the surface of the insulating material. It thus becomes important to design plugs so the pins are far enough apart as well as separated sufficiently from the shell. Also helpful is the lengthening of the effective electrical path between points by adding ridges or grooves to the surface. Insulating material that has a high surface voltage breakdown must be used. Of the many materials tested in AN plugs, melamine has been found to be the best, since it has the highest voltage breakdown at 40,000 ft.

For a ¼-in. air gap the breakdown voltage is about 3.7 times greater at sea level than at 40,000 ft, while for a 1/32-in. gap it is about 2.7 times greater. These data can be used as a

guide in considering spacing between components that might arc over.

On some switches the energy dissipated during arc rupturing was sufficient to char the surface of the plastic popularly used to house the contacts. Occasionally, the plastic actually burnt, while in other cases, after the arc was extinguished, the gases containing vapor from the plastic formed during charring cooled and a thin film of plastic was condensed on the contact surfaces. This plastic is sometimes a good insulator, preventing the contacts from closing the circuit the next time the switch is actuated. Contact manufacturers should use insulating material around the arc rupturing parts that does not burn or give out vapors that will condense on insulating film on the contacts and double-contact switches in place of single-contact ones, if possible.

EFFECT OF LACK OF MOISTURE

The lack of moisture in the air at high altitudes caused several difficulties. It seemed, at least in part, to be responsible for the very rapid wear of electrical brushes at 40,000 ft, even those treated for high-altitude operation, on generators, alternators, inverters, motors, and other rotating electrical machinery.

In general, brush life is prolonged by an electrical conducting oxide film between the brush and the slip ring or commutator. At low altitudes the moisture present in the air serves as a catalytic agent to promote oxidation of the copper, but the moisture content at 40,000 ft is only 1/2000 that at sea level, so that insufficient moisture is present to form this film.

Without the film the brush erodes quickly because it rubs against the metal surface. The problem becomes one of supplying a catalytic agent that promotes the oxidation of the copper by the oxygen in the air, but, at the same time, does not boil out at the brush temperatures encountered, has good electrical conductivity, is noncorrosive to metals used in aircraft, and provides the necessary lubrication between brush and metallic surface.

The change in moisture content between altitude and sea level was quite troublesome in some electrical units. For example, some limit-switch housings that were supposed to be moisture tight allowed 1-2 tablespoonsful of water to enter and freeze the plunger as well as the actuating part of the limit switch. During a descent from 40,000 ft to sea level, the outside air usually changes from about -75 F to about 60 F in 30-35 min. Solid parts of the airplane do not change temperature that fast. This was the case with some of the limit switches, so that the water vapor penetrating the inside condensed and froze. In some cases coats of ice formed between electrical contacts, preventing the completion of an electric circuit when the switch was closed. These troubles were eliminated by using sealed electrical contacts.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

Two New Steels Made Standard

TWO new steels recently were added to the SAE Standard Steels. They are 1039, a carbon steel, and 8719, a triple alloy steel.

Analysis of the 1039 steel is: 0.37-0.44 carbon; 0.70-1.00 manganese; 0.040 max. phosphorous; 0.050 max. sulfur. The 8719 steel chemistry is specified as: 0.18-0.23 carbon; 0.60-0.80 manganese; 0.040 max. sulfur; 0.040 max. phosphorous; 0.20-0.35 silicon; 0.40-0.70 nickel; 0.40-0.60 chromium; 0.20-0.35 molybdenum.

Both the 1039 and the 8719 steels will be incorporated in the SAE Iron and Steel Specifications, revised late in 1947. (For other steel specifications, see article "Postwar SAE Steels," SAE Journal, November, 1947, pp. 17-23; also article "Postwar SAE Steels, Part II," SAE Journal, December, 1947, pp. 59-61.)

ALUMINUM BODY STAMPINGS

BASED ON PAPER* BY

J. H. Dunn, E G. Kort and G O. Hoglund

ALUMINUM CO. OF AMERICA

(This paper will be published in full in SAE Quarterly Transactions)

ALTHOUGH considerable aluminum is being used by automobile manufacturers to ease the steel shortage, the aluminum industry would prefer to see primary attention devoted to those parts where the light metal is the best material for the purpose, and can be justified on its own merits.

Practically anything that can be made of steel can be made with aluminum.

Five million cars a year require 3,000,000 tons of sheet steel for bodies alone. Assuming an average of 1200 lb of steel per body, 1,000,000 tons of aluminum would be required to displace that steel. The nation's total capacity of sheet aluminum is hardly 500,000 tons a year.

A small portion of the automotive industry's tonnage would be attractive. As the automotive industry becomes better acquainted with the design and production of aluminum parts other applications will be found where the light metal can compete, from the standpoint of its inherent merits.

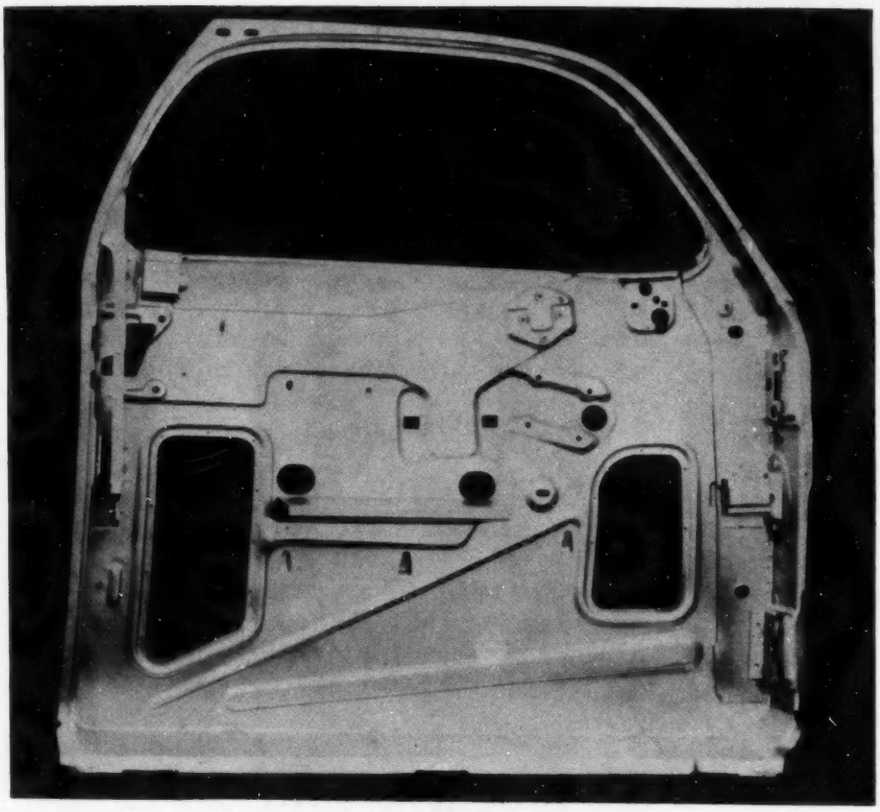
Doors and deck lids which are handled manually have been built. An aluminum

Aluminum Automotive Parts

Among the parts that have been successfully fabricated from aluminum for automobiles are:

Running boards ... stone deflectors ... fender braces ... radiator air ducts ... Toe boards ... glove compartment doors ... instrument panels ... gas tanks ... doors ... hoods ... hub caps ... deck lids ... heater housing and deflectors ... heater fans ... cowl ventilator covers ... carburetor air cleaners ... seat adjustment parts ... garnish moldings ... accelerator pedals ... headlamp mounting rings ... headlamp housings and reflectors ... valve covers ... transmission covers ... license plate brackets.

*Paper "Aluminum for Body Stampings – Selection of Alloys, Drawing, and Joining" was presented at SAE Passenger Car and Production Meeting, Detroit, March 3, 1948.



● Aluminum alloy automobile door which was formed over existing tools made to press steel

motor coach door weighs 66 lb., in steel it weighs 101 lb. An aluminum deck lid requires 16 lb of effort to lift, and a steel lid of the same size requires 26 lb. This type of substitution appears to open the field for aluminum in the automotive field.

Alcoa No. 2 automotive sheet has a good combination of strength, resistance to corrosion, workability, and price for automotive use. It is of the magnesium-aluminum type.

Superior in workability, but somewhat lower in strength, is Alcoa No. 3 automotive sheet. It has excellent resistance to corrosion.

These two alloys, and 52S which in some cases exhibits better drawing characteristics than No. 2, are available in the annealed, intermediate, and hard worked tempers obtained by cold working.

Alloy 61S is heat-treatable, and promises to be of value to the car manufacturer. Small parts can be batch treated.

Tool setups for drawing steel must be modified when used to form aluminum alloys. Sometimes sequences must be changed.

Most important is assurance that the metal has free flow in the forming dies. Percentage of reduction must not be too great, tight clearances between the punch and die must be relieved, and the blank-holder pressure should be held to the minimum that will prevent buckling. Subsequent operations fail to iron out buckled aluminum alloy.

Lubrication is extremely important. Mineral and compounded mineral oils are chiefly used. Water soluble lubricants have not been successful. Sometimes when such lubricants produce a satisfactory draw, they tend to attack the metal if not quickly removed from the finished part.

MANY WELDING TECHNIQUES

Gas, metal arc, carbon arc, and argon shielded tungsten arc, spot, seam and flash resistance welding, and furnace, flux bath, and torch brazing can be used to join aluminum.

But techniques must be modified because aluminum does not behave like ferrous metals do. Mechanized welding processes have been developed to decrease joining costs in many instances.

The No. 3 automotive sheet has the best weldability. Little or no trouble has been experienced from cracking in or near welds, fusion welds have excellent ductility, and a minimum or no surface preparation is required for resistance welding.

METHOD OF WELDING

On production work, welding should be done in the downhand position to obtain best welding speed and low cost. Here the flux coated rod is fed into an area of an arc drawn between the electrode and the parts being joined.

Verticle position welding is possible, but is slower than the downhand position. Best results are with a rod either extruded or dipped coating that is thoroughly dried and is about half the thickness of the coating on metal arc welding electrodes.

Argon shielded tungsten arc welding has a good many specific advantages over other fusion welding processes. Usually an ac current is used in a blanket of the gas. High frequency current is superimposed on the welding circuit to establish and stabilize the arc. Mechanized welding at higher voltages can be operated without high frequency stabilization.

Requiring no flux, this method has the advantage of requiring no flux removal. Precleaning is accomplished by a wire brush or hand rubbing with steel wool just before welding.

Argon welding speeds of more than 200 in. per min have been reached in mechanized welding of 0.64 in. sheet at a gas consumption of 30 cu ft per hr. At 9¢ per cu ft of the inert gas, argon costs 2.7 mills a foot of weld.

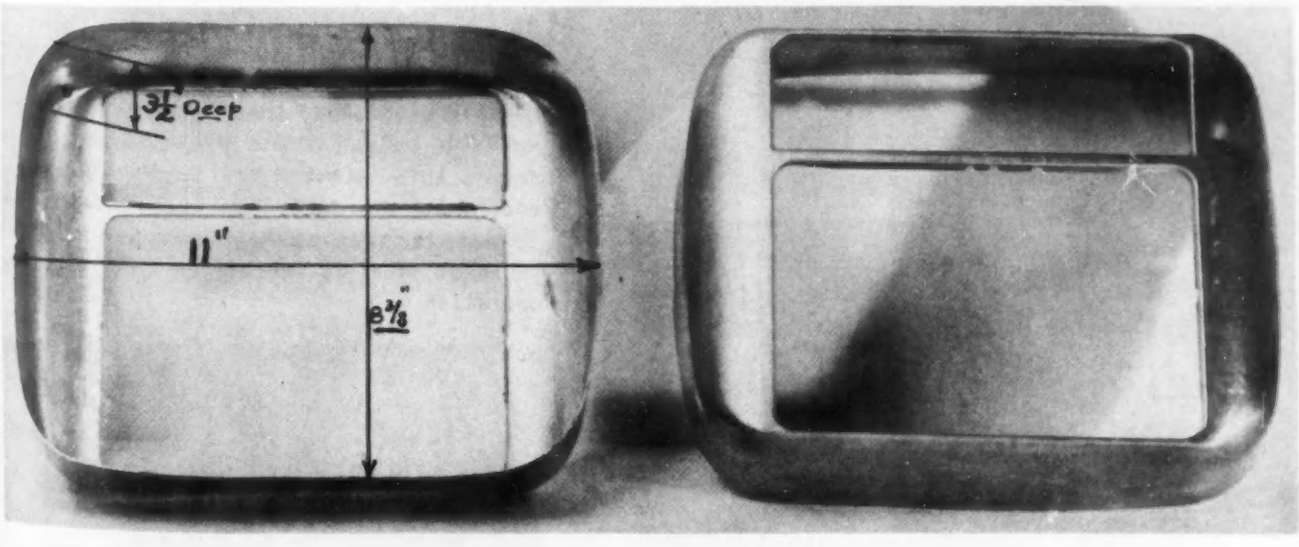
Spot, seam, and flash welding are used extensively for joining automotive parts. Specialized and expensive equipment has been developed to reduce costs.

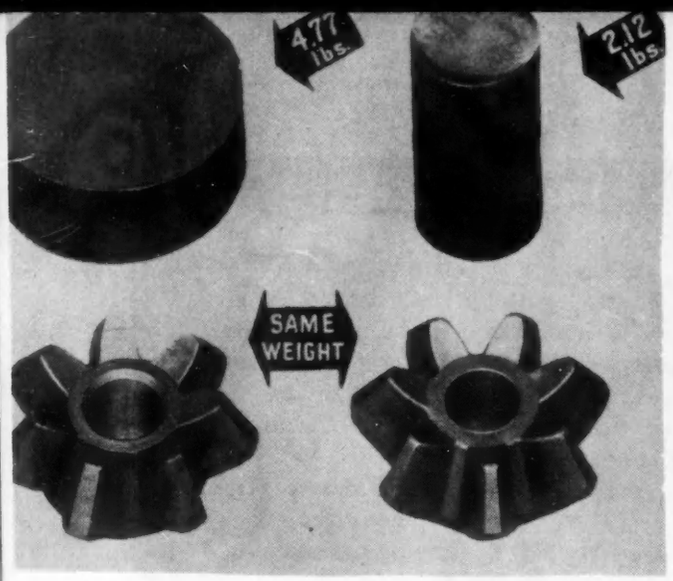
Strength and resistance to corrosion of brazed joints is about the same as that of welds. Little or no melting occurs in the parent material, but the temperature is raised above the annealing point for both cold worked and heat treated aluminum.

All brazing requires a flux which must be cleaned from the work. Fluxes may be corrosive, and their presence will not permit good adherence of paint.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

• Automotive heater case drawn from Alcoa No. 2 H-32 (¼H) temper. Annealing one end was accomplished by dipping in molten nitrate bath at 700 F for 2 min





MACHINED FORGED

4.77 lb - 2.12 lb = 2.65 lb saved

Timken-Detroit differential pinion at left was entirely machined from bar stock. Pinion of same size at right was press forged from a 2.12 lb billet and machined in finishing operation.

FORGING Used To RE

BASED ON PAPER* BY J. H. Friedman
Vice-President and General Manager
National Machinery Co.

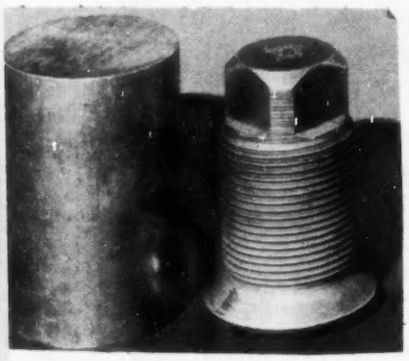
MILLIONS of pounds of steel are being saved annually by substituting recently-developed precision forging and rolling for automatic machine screw machines.

Timken-Detroit Axle Co. developed this process during the recent war as a means to save material. Some examples of its application are shown on these pages.

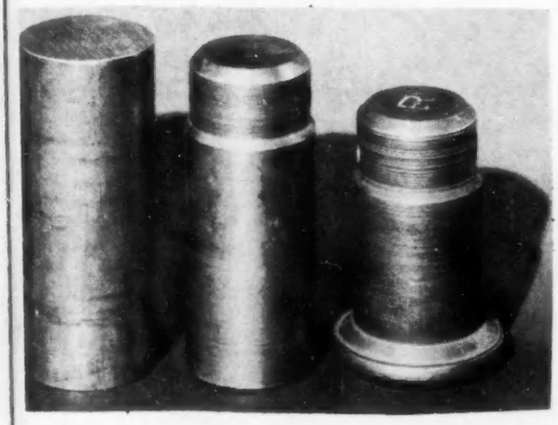
Combining cold header, the Maxipres, automatic induction heating, and a new

*Paper "Development of Low Weight Forgings" presented at the SAE National Passenger Car and Production Meeting, Detroit, March 3, 1948.

Evolution of Nut

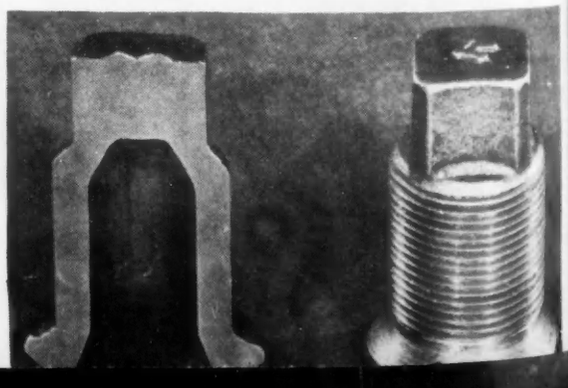


1. Made on a screw machine, this truck wheel nut was worked down from solid bar stock by turning, boring, milling, and threading. Bar stock weighed 18 oz. machine finished nut weighed 6 oz. Scrap loss 12 oz, or enough to make two additional nuts.



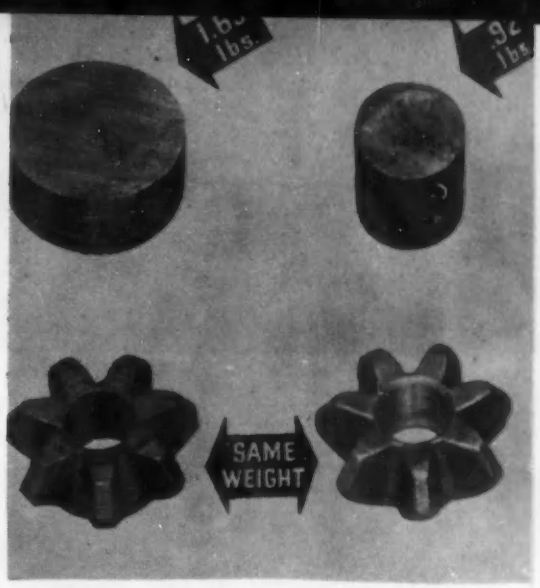
2. Next improved method was a combined screw machine and cold header job. Bar stock weighing 12 oz. at extreme left. Screw machine operation hollowed the bar, and cold header flared the bottom end. Saving of 50% in scrap was achieved.

3. Third process was combined cold header and Maxipres forging. Six oz. coiled road cut to length formed on a cold header, center. Part was heated by induction and finish forged in one stroke in Maxipres. Metal from hole was displaced into the forging. A 3/4 in. double blow cold header, teamed with two Maxipres forgers working full time, could save 5,000,000 lb of material as compared with the older screw machine method 1 above.



4. Half section of forging as it comes from Maxipress, and the finished nut. Inside formed hole is bored and tapped, the bottom end up to the square is machined, and external threads are rolled. Less than an ounce of metal is removed by final machining operation.

To Reduce Scrap



MACHINED FORGED

1.65 lb - 0.92 lb = 0.73 lb saved

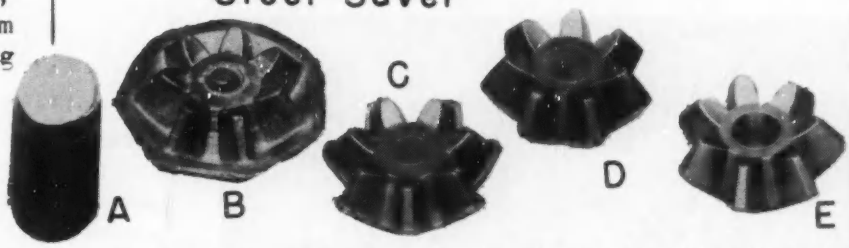
Smaller differential pinion previously entirely machined (left) and forged (right). Saving was 0.73 lb of steel, or nearly enough to make another pinion of same size. Steps shown below.

machine for rolling called the Maxiroll, many automotive parts are being formed and finished without machining or thread cutting.

Material savings lie in the fact that, by proper teaming of the machines, the final forging is nicely filled at every point without any excess stock.

Besides the examples shown here great savings in material and time have been recorded in making automobile tie rods, automobile seat regulator rods, cam shafts, wrenches, steering arms, steering spindle arms, and other parts.

Steel Saver



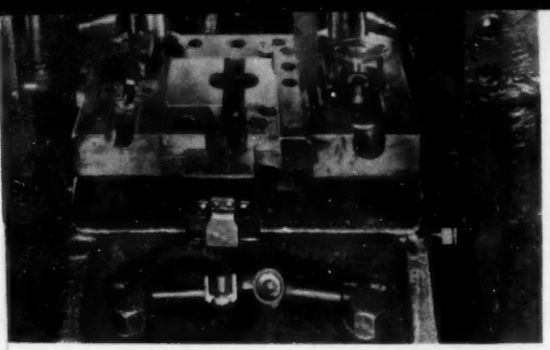
High traction pinion, formerly produced entirely by machining methods, is now formed and finished in these stages: A. Bar stock; B. The first forging operation rough forms the pinion; C. Second coin forging before being trimmed; D. Forge trimmed before being machined. E. After machining.

Speed Team

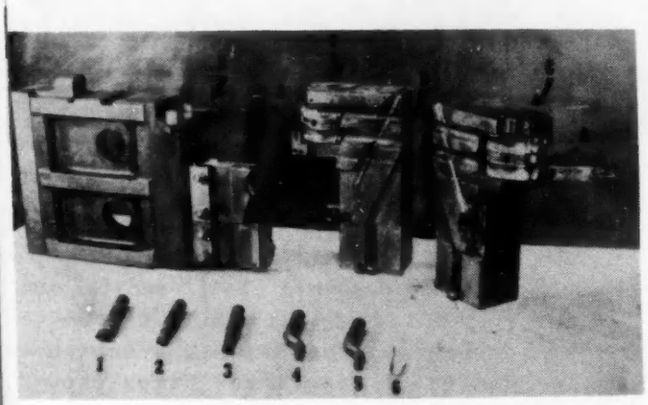
Cold header and Maxipres were teamed up to produce automobile tie rods. 1. Blank cold headed from coiled stock at rate of 60 per min; 2. Reduced end extruded; 3. Semi-spherical end is upset; 4. Large end automatically induction heated and finish forged on Maxipres.

Gear Is Forged

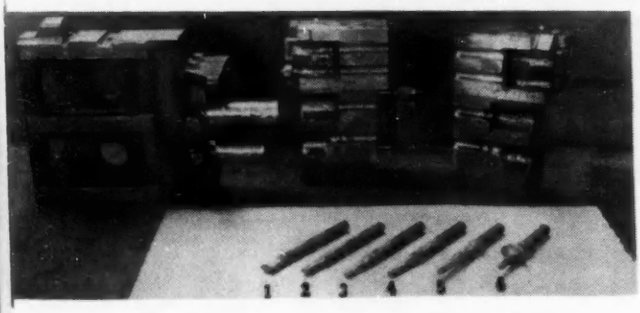
Five stages in forging a segment gear begins with the first four operations made cold on a four-station three-die progressive header from the 0.704 in. diameter wire. The cold forging is then hot trimmed in a press and then machined. The finished gear weighs 0.56 lb, a saving of 1.4 lb per forging, or enough to make 3½ gears from the amount previously used to make one.



Maxipres die in which hot forging operations are handled. The first pass, in left hand impression of die, partially shapes the stock for cup of tie rod. A split die is in middle impression with left hand half stationary, the other movable and actuated by wedge attached to upper die. The hole is punched in right hand impression.

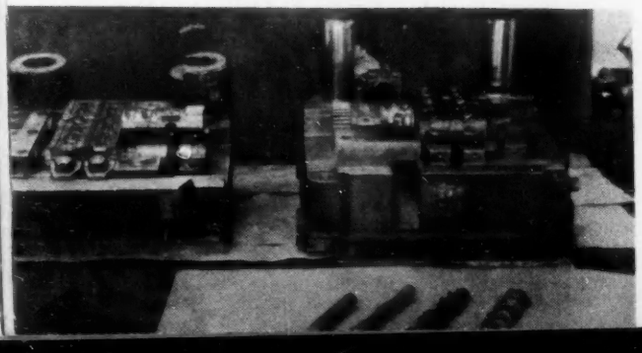


Forging machine die (early model) for new rolling method to reduce end of stock before final forging. When dies close on heated blank the stock is squeezed between segment rolls. As the heading slide moves forward, rollers A, engage cam plates B, which causes rolls to revolve around fulcrum pins C. This forces blank to move laterally in groove D, forming the blank 1. The blank is rotated 90 deg and again feeds into the same step die to form 2. Reducing in one pass in the second step of die forms the shape 3. Forming the shapes 4 and the trimming, blank 5, are done in remaining two impressions of the die. Minute amount of flash, shown at 6, keeping scrap to minimum.



Same rolling method is used to give stock two rolling passes in each impression, being rotated 90 deg between each pass. Results shown at 1,2,3 and 4. Forging is completed in the two bottom steps of the die, 5 and 6. This is preliminary to finishing in the Maxipres, shown below.

Maxipres die finishes the blank 1, left, which had been formed as shown above and numbered 6. It is bent in the form of 2, further shaped as shown at 3, and finally finished, 4. This new rolling method of forming keeps flash to the minimum, and the finished form is sharp in detail.



Here the entire forming of a camshaft is done in three steps in a Forging Maxipres. The rolling or breakdown operation takes place at the left. Two segment gears, one in the upper and the other in the lower die, A, actuate the breakdown rolls which rotate together when the gears mesh during the down stroke. The hot bar, 1, is fed in at B butted against the gage C. As the downward stroke progresses, the blank is rolled forward and shaped in the form shown in 2. The final forging is made in two passes, resulting in 3 and 4. Again, the minimum of stock is used

ARC WELDING Shrinks Prop Hub Cost, Weight

EXCERPTS FROM PAPER * BY
John D. Waugh
Public Relations Representative
Aeromatic Propeller Department
KOPPERS CO., INC.

Redesigning propeller hubs for arc welding instead of forgings saves steel, lowers production costs, and reduces weight, says Waugh. These economies are particularly timely in the light of the present labor cost and steel situations.

He tells how to design for welding and describes the production welding technique for fabricating these hubs.

This work, incidentally, was awarded the first grand prize of $13,200 in the Design-For-Progress Award Program of the James F. Lincoln Arc Welding Foundation. Waugh helped prepare the prize-winning paper.

PRODUCTION arc-welding Aeromatic propeller hubs will save Koppers over $205,000 in direct labor and raw materials this year at the present rate of production.

Recent research into propeller-hub manufacturing techniques showed present methods of machining hubs from steel billets are expensive, wasteful, and impose unnecessary weight penalties on the entire assembly. Arc-welding the principal component permits use of tubes, drop forgings, and simple machinings that yield cost reductions not possible with any other practical process. It makes for manufacturing flexibility. . .all adjustment devices are disposed of externally so that inner works need not be disturbed and minor changes can be made with no appreciable tooling cost.

COST CONSIDERATIONS

Cost and weight data, consolidated in Table 1, show exact savings realized with arc welding versus forging with the Model 220 hub. Total figures are given in all instances. The 42.8% cost reduction determines the price and extent of the market more than any other factor. However, weight saving of 31.5% is almost equally important due to its influence on total aircraft weight, and can be applied to the personal plane in terms of increased performance without the increased cost of greater horsepower. Even greater savings, shows Table 2, are in the offing for the experimental Model 200 hub.

Indirect benefits, such as greater

*Paper "Arc Welded Propeller Hubs Reduce Cost-Weight," was presented at SAE Baltimore Section, Jan. 13, 1948.

TABLE 1 - WEIGHT AND COST DATA OF FORGED VERSUS WELDED MODEL 220 PROPELLER HUB - REPETITIVE PRODUCTION

	Raw Material Weight	*Raw Material Cost*	*Standard Machine Time Man Hours*	*Direct Labor Cost*	*Total Cost (Including Burden)*	*Finished Hub Weight*
FORGED HUB	64.7 lb	$10.36	16.4 hr	$20.50	$61.61	17.8 lb
WELDED HUB	47.1*	6.80+	9.1x	11.38	35.25	12.2
GROSS SAVINGS	17.6	3.56	7.3	9.12	26.36	5.6
% SAVINGS	27.2%	34.4%	44.5%	44.5%	42.8%	31.5%

* Includes 1.2 lb Planeweld No. 1
\+ Includes $.14 Welding Electrode Cost
x Includes .98 hr Welding Time

TABLE 2 - WEIGHT AND COST DATA OF FORGED VERSUS WELDED MODEL F-200 PROPELLER HUB - REPETITIVE PRODUCTION

	Raw Material Weight	*Raw Material Cost*	*Standard Machine Time Man Hours*	*Direct Labor Cost*	*Total Cost (Including Burden)*	*Finished Hub Weight*
FORGED HUB	76 lb	$9.12	20.5 hr	$25.62	$73.17	8.8 lb
WELDED HUB	21.5*	2.84+	4.83x	6.04	17.94	5.6
GROSS SAVINGS	54.5*	6.28	15.67	19.58	55.23	3.2
% SAVINGS	71.7%	68.8%	76%	76%	75.5%	36.4%

* Includes .95 lb Planeweld No. 1
\+ Includes $.11 Welding Electrode Cost
x Includes .63 hr Welding Time

baggage capacity, become factors of utility which are competitive points within the industry. Prior to the successful application of this welding technique to the hub manufacture, it was found that a propeller hub scarcely ever broke from steady stress, which was calculable, but generally failed from the fatigue due to vibratory stress. Since the latter stress was not easily determined (and is still the source of much investigation), enormous safety factors in terms of metal bulk were built into propeller hubs.

Finest high alloy steel forgings obtainable became the generally accepted hub material. These huge forgings represented high cost from start to finish and still do, as in the case of a present high horsepower hub. It has a pierced forging, weighs approximately 300 lb, and is machined down to about 50 lb. However high structural integrity has been achieved, and retention of blades against centrifugal loads of 75 tons and more is no longer a problem with the large propellers.

It is the effect of this accepted, and now traditional, method of high-power-absorption hub construction on the design of low horsepower propellers, which

provides a basis for this comparison.

Welding for hub fabrication among numerous developers apparently just wasn't considered because of the view that welding would not be strong enough for this very highly stressed part; also, forging was the only practice in successful use. The one notable exception taken to this view is embodied in manufacture of the present Aeromatic variable-pitch propeller hub.

HUB DEVELOPMENT

The original steel hub forging (on Model 220), with some preliminary machining completed, is shown in Fig. 1 with the finished machined and ground hub. The forged billet of chrome-moly steel weighed 64.7 lb and was machined to a finished weight of 17.8 lb.

Design characteristics of the finished hub include the large cylindrical socket, into which the blade retaining flange and retaining nut fits, and the cross bore through the hub center, which is splined to fit a particular size engine shaft.

These two principal bores must have an accurate dimensional and high strength relationship because of the retention of the entire centrifugal and bending loads of the blades by the large cylindrical hub socket, and the engine driving torque by the shaft bore. Other integral features of the hub shown are: buttress threads for blade retaining nut; boss in base of hub socket to position the blade journal bearing; aperture through side of hub wall for a shaft; and a milled slot from one socket to the other to accommodate a gear to synchronize blade movement.

These features are indigenous to the Aeromatic propeller design in that they comprise all principal hub features in the absence of any actuating mechanism requiring auxiliary power.

Controllable-pitch propellers may have similar basic hub structures with pitch change mechanisms added. But, in the absence of the servo devices, the retention of blades so they may rotate, adjustable stops to limit their movement, and a synchronizing means comprise the

●Fig. 1 - The propeller hub made from a forging, above, was redesigned for arc welding, as below. The welded hub is 42.8% cheaper and weighs 31.5% less than the forged job

total basic hub requirements.

Pitch setting stops, which limit angular blade travel, were in an inconvenient spot in the forged steel hub design. Changing their settings is a procedure which must be performed repeatedly when the propeller is being adjusted to control engine speed accurately. Removal of the entire blade assembly, each time adjustment becomes necessary, entailed considerable time.

Such features, in addition to the disadvantage of carving the whole hub out of a forging, could be improved only by an entirely new design fabricated by another method.

Steel castings had demonstrated weakness and aluminum alloy forgings, though light, were virtually as expensive to machine as steel and also would fatigue. Welding was the apparent solution, although it had never been used in this particular application.

DESIGN FOR WELDING

In the breakdown of the 220 hub for welding, the barrel and cross tube, shown in Fig. 1(b), were machined from seamless alloy steel tubing. To expose the pitch setting stops for adjustment, bosses made from bar stock were designed to be welded into holes in the hub barrel wall and threaded for externally accessible bolts. Synchronizer shaft, which had previously been bolted to the hub wall, was to be threaded into a boss machined from bar stock and welded to hub wall. With the cross tube welded into hub barrel, the boss for positioning the inner journal bearing (also machined from bar stock) could be welded to the cross tube.

To balance the assembly, a simple piece of curved plate would be welded to the inner hub wall. Threading the inner lip of the hub barrel for a retaining nut was eliminated by using an internal expanding snap-ring in a groove. Manufacture of these parts was far less costly than a forging and its machining. Substantial weight reduction was possible because superfluous metal, not removable economically from the forging, if at all, was absent with the tubular construction.

Hub barrel and cross tube of the present design are machined from electric-furnace, aircraft-quality, seamless steel tubing (SAE 4130) purchased in finish annealed condition. Both hot-finished and cold-drawn tubes have been welded with success. The bearing boss, welded to the cross tube, is 4130 steel. Synchronizer boss, pitch stop bosses, and balance weight are all SAE 1020, normalized. These parts, shown in Fig. 1(b), may be referred to in the following welding sequence.

WELDING STEPS

Cross tube is positioned through holes bored in hub barrel in a jig holding the balance weight against hub inner wall, and synchronizer boss in position in hub wall. These components are then atomic-hydrogen tack-welded, making smooth shallow tacks that may be passed over with an arc later with no perceptible rise or slag. The tacked assembly is preheated to between 500-600 F, then placed in a positioning jig. A fillet weld is made first at junction of cross tube and hub wall, externally, with a 5/32 in. diameter Planeweld No. 1 electrode using approximately 130 amp.

After this the hub is normalized for 1/2 hr at 1500F and cooled in still air. It is then shot-blasted with angular shot, the welds ground, and holes drilled in hub wall to receive pitch stop bosses; the transverse hole in the cross tube is reamed to receive the bearing boss. This intermediate machining is necessary so that stresses in the welds of smaller parts, yet to be added, are minimized.

Stop bolt bosses are now fitted into the holes in hub wall and atomic-hydrogen-tacked in a jig. Bearing bosses are pressed into cross tube and hub is again preheated to 500-600 F. Welding is accomplished with 1/8-in. electrodes laying a fillet bead at one pass around each boss on external surface of hub wall.

Penetration of the weld at the bosses is not required to be as great as that of welds at either end of cross tube because they do not carry appreciable loads. Cross tube-to-hub barrel weld, however, does carry substantial shear stress due to torque and must be entirely free from defects which torsional vibration could aggravate.

Following final welding, hub is again normalized and heat-treated. It is

quenched in oil at 1550 F and drawn at 1020 F for 4 hr. After final shot blasting, hub is Brinell tested for a 250-276 reading and given a ferro-magnetic inspection check before grinding and final machining.

Tubular hub components receive a good turned finish initially so only the weld bead needs blending attention. A splatter-proof coating reduces adherence of weld particles and subsequent shot blasting removes particles that stick. Slag is also removed by shot blast, eliminating hand removal for any purpose other than exposing the end of a bead for continuance of welding or for weld inspection.

Welds are ground with coated wheels and Carburs, the blended area extending approximately 3/8 in. on either side of weld. After grinding, the hub is thoroughly inspected by the wet magnetic method for cracks, slag inclusions, or excessive porosity.

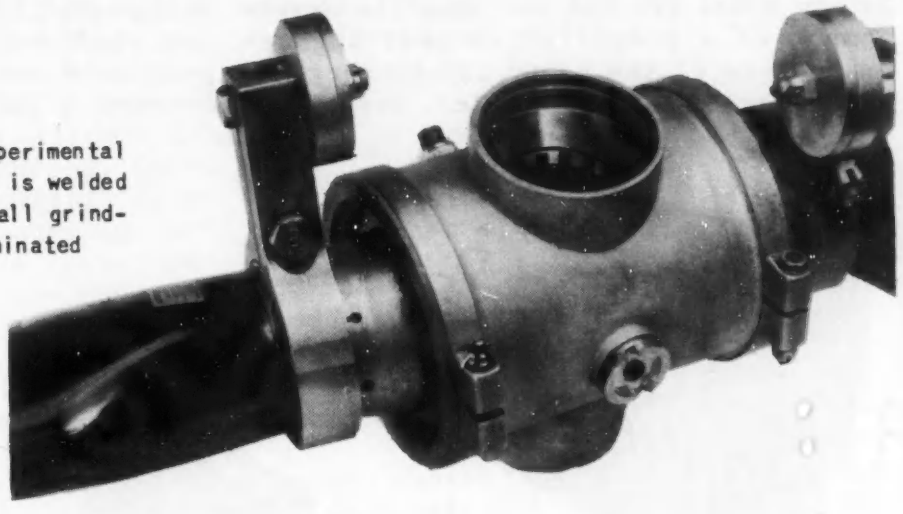
The welding technique of experienced operators is so highly developed that rejections are unbelievably low and not comparable to machining rejections in quantity.

Welded jigs are freely mounted and counter-balanced so they may be swiveled by light touch with no tendency to produce irregular motion. Heavy universal jigs were found to lag or jerk from friction of weight and inertia, preventing steady rotation and smooth tilting during welding.

As time figures in Table 1 show, welding of this hub, while of a precise and critical nature, has been reduced to a repetitive technique that may be conservatively considered to have no known parallel in its class.

EXPERIMENTAL TREND

A current experimental development is shown in Fig. 2 - Model 220 hub welded internally, object being to eliminate weld grinding completely and accomplish a new disposition of the pitch stop bolts by dispensing with their bosses.



● Fig. 2 - This experimental Model 220 hub is welded internally and all grinding is eliminated

As previously noted, the cross tube was welded to hub barrel at front and rear, the synchronizer shaft boss and four bosses also were welded, all externally, into hub wall holes. Grinding naturally entails time and cost, particularly around pitch stop bosses. By making all pitch stop boss welds internally, no structural change is necessary and cost savings are reflected.

The balance weight (previously a small thick block) was made out of thinner plate covering a greater area of the hub wall and welded in place as before. This gives greater wall thickness through which pitch stop bolts may be threaded without supporting bosses. Potential advantages of eliminating the four machined pieces merely by inclusion of a larger weld plate indicate the extent of total benefits which may become possible with arc welded fabrication.

This development-quite new and still

undergoing extensive test-is offered primarily to emphasize fabrication versatility and design latitude permitted by arc welding. If it should supplant the current production hub, there would be no machining jig changes, only one drill jig change, and only slight modification in arrangement of welding jig. Thus, what could be an expensive engineering change-considering machining methods-can result in a beneficial modification with immediate savings.

Paralleling the evolution of the 155 to 245-hp Model 220 hub has been the development of a propeller to meet the requirements of the 65 to 150-hp range of light aircraft. This propeller, designated Model F-200, operates exactly like the larger model.

Chief difference, exclusive of size, between the two models is that the F-200 is specifically designed to be mounted on the flange shaft engines characteristic only of the lower horsepower field. This method of propeller mounting requires the hub to have an integral flange to fit the engine crankshaft end, which is flanged rather than splined and extended as in the case of the Model 220 application.

From the standpoint of propeller hub design the flange is ideal. Eliminating the shaft which passes through the hub permits a reduction in barrel length of between 3 and 4 in. with a substantial weight saving. The blade retaining flanges may be brought together to within an inch of one another. This permits the use of a single, common support, or strut, for a simple extensionable pilot which acts in a manner similar to the bearing boss in the larger model and simultaneoulsy provides a preloading means.

With the blade flanges so close together it is ob-

● Fig. 3 - Machined split hub (Koppers Model F-200) made from a forged billet, above, gave way to the lighter, more economical welded design below

vious that the synchronizer gear and flange gear segments common to the large model cannot be used to coordinate blade movements. This situation is turned to a good end by using curved link arms fitted to pins on the butts of the flanges and extending forward to fit a wrist pin passed through their ends and through a plastic piston.

It can be assumed that this basically simple mechanism should have a hub structure likewise uncomplicated in form or function and not difficult and expensive to manufacture. The first hubs belie this assumption because they were made, like the first Model 220 hubs, out of forgings.

Fig. 3(a) is a comparison of the first flange type hub to a forged billet like that from which it was machined. Both aluminum alloy and steel forgings were used in addition to tests of castings and malleable iron machinings. The latter two materials proved unsatisfactory because of their fatigue characteristics. Aluminum forgings had sufficient strength for experimental work, but were known to fail from fatigue as the larger model experimentation had taught.

When the hub was machined from an aluminum alloy forging, the necessary forging weighed 43 lb and the hub 3 1/4 lb. It was obviously a little less than reasonable to expect an economically practical structure on this basis. Forged steel was employed with more success, although the billet weighed 76 lb and the finished hub 8.8 lb.

Comparison of a completed F-200 hub machined from a forging and the present welded hub may be studied in Fig. 3 (b). Here, some of the disadvantages of the previous design are obvious, mainly the split barrel construction. This type of arrangement for enclosing the bearings and synchronizer and retaining the blades by integral lips on the barrel ends did eliminate retaining nuts, but imposed other penalties.

The milling to provide bosses for the clamping bolts was intricate and expensive. To insure perfect alignment of the halves, the thrust bearing assemblies on the inner ends of the blade flanges were enclosed in steel sleeves. Also, the split hub made any sort of journal bearing strut inconvenient, so a spacer between large steel balls provided preload and journal support. The synchronizer cylinder was detachable from the front of hub and gave some difficulty when adjustment of pitch limits was necessary.

From the manufacturing standpoint, the other disadvantages of machining the whole unit from solid stock are apparent. The cost-weight figures in Table 2 detail the advantages of arc welding the Model F-200 hub.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

■

FASTENERS: Development of physical property specifications for nuts, bolts, and other fasteners has just been assigned to a new group of the SAE Iron & Steel Technical Committee. Determination of test methods and their interpretation also is part of the program to give industry a yardstick for fastener performance, in addition to already-available dimensional standards. Yield strength, elongation, and hardenability are among the properties being considered by the group, headed by H. Bornstein, Deere and Co.

FINISH DETECTIVES: Trying to find a practical means of identifying character of surface finishes, the SAE Surface Finish Committee is looking into possibilities of adapting the Bertillon finger-print method principle. This group is searching for an instrument and technique that will permit specification of surface finish without tying it down to manufacturing processes such as lapping, honing, and grinding. It is said that these processes differ from city to city, from plant to plant - even within a single company.

DIESEL ENGINE WEAR Speeded by Slowed by

BASED ON PAPER* BY

Warren G. Payne

Head, Experimental Engines Branch, Internal Combustion Engine Laboratory

and William F. Joachim

Superintendent, Internal Combustion Engine Laboratory

U.S. Naval Engineering Experiment Station

(This paper will be published in full in SAE Quarterly Transactions)

SURFACE disintegration should now be recognized as a member of the diesel engine wear-factor family along with corrosion, abrasion, and scuffing, according to experience of the Naval Engineering Experiment Station. Porous chromium plating, tests show, protects the cast-iron surface from this newly-discovered mechanical surface breakdown and its fellow wear catalysts.

This fourth type of wear, believed to be the cause of many cylinder failures, consists of metal loss from the cylinder bore wall in the form of fine particles separated from the liner surface. Particles come from two sources.

First is the Beilby Layer of fragmented metal, partially or wholly ruptured from the main crystalline body. It may be formed by excessive heat and high pressure during machine finishing or by run-in of a new liner with a not-smooth-enough surface. It's really a smeared surface.

Second source is hard particles separating from the soft matrix, found even in the most acceptable cast-iron liner surfaces. Cast-iron growth may speed formation of a surface condition susceptible to particle separation.

Shearing action or cavitation by oil films under pistons and rings separate hard particles (Beilby Layer or normal surface types) from the surface. Any corrosive action present would tend to loosen these particles. Surface fatigue from repeated stress reversals under pistons and rings also weaken and break particle bands. And foreign abrasive material would tend to force them out.

But there's evidence that normal piston and piston-ring action can separate them too. There's no indication of piston or piston-ring welding in initial stages of this wear; it sometimes happens only below the compression-ring travel area.

Carried between pistons, rings, and liner, the hard particles form a fine abrasive that may cause wear of all parts and loosen other abrasives in the process. This abrasive action may wear the cylinder. Extremely minute particles may produce a smooth, uniform, polishing wear; fairly large particles can scratch or even groove the surface.

Piston-ring wear will increase in proportion to the amount of material released, if particles are large enough to

*Paper "U.S. Naval Engineering Experiment Station Investigations on Cylinder Liner Wear," was presented at SAE Annual Meeting, Detroit, Jan. 15, 1948.

by Surface Disintegration
by Porous Chrome Plating

cause abrasion. But this kind of wear generally is confined to removal of fine particles, flushed off with the lubricating oil. In many cases there is no piston abrasion, only "normal" piston-ring wear.

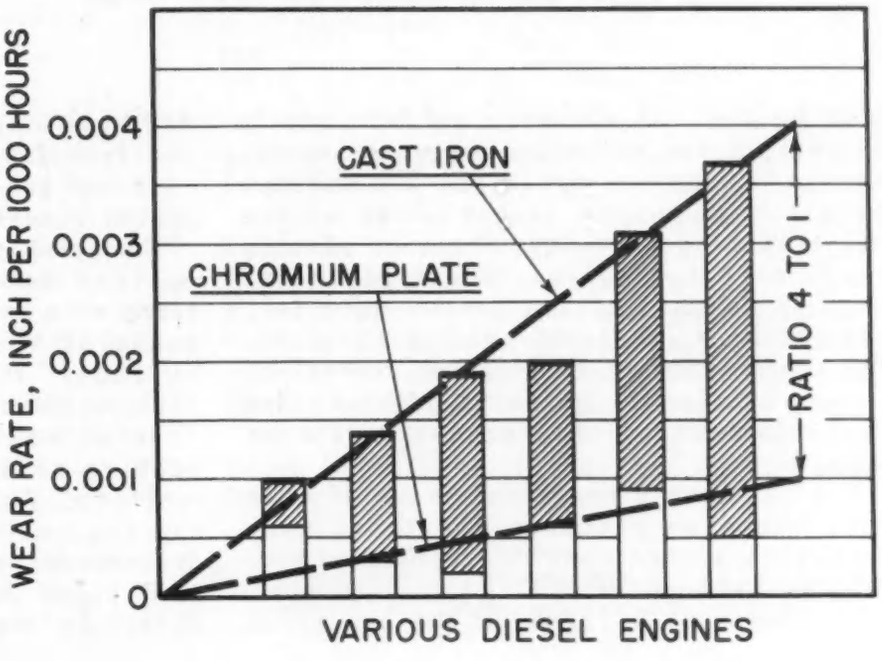
RETARDING WEAR

Antidote to surface disintegration proved to be porous chromium plating. It reduces cylinder wear 75% and even lowers ring wear.

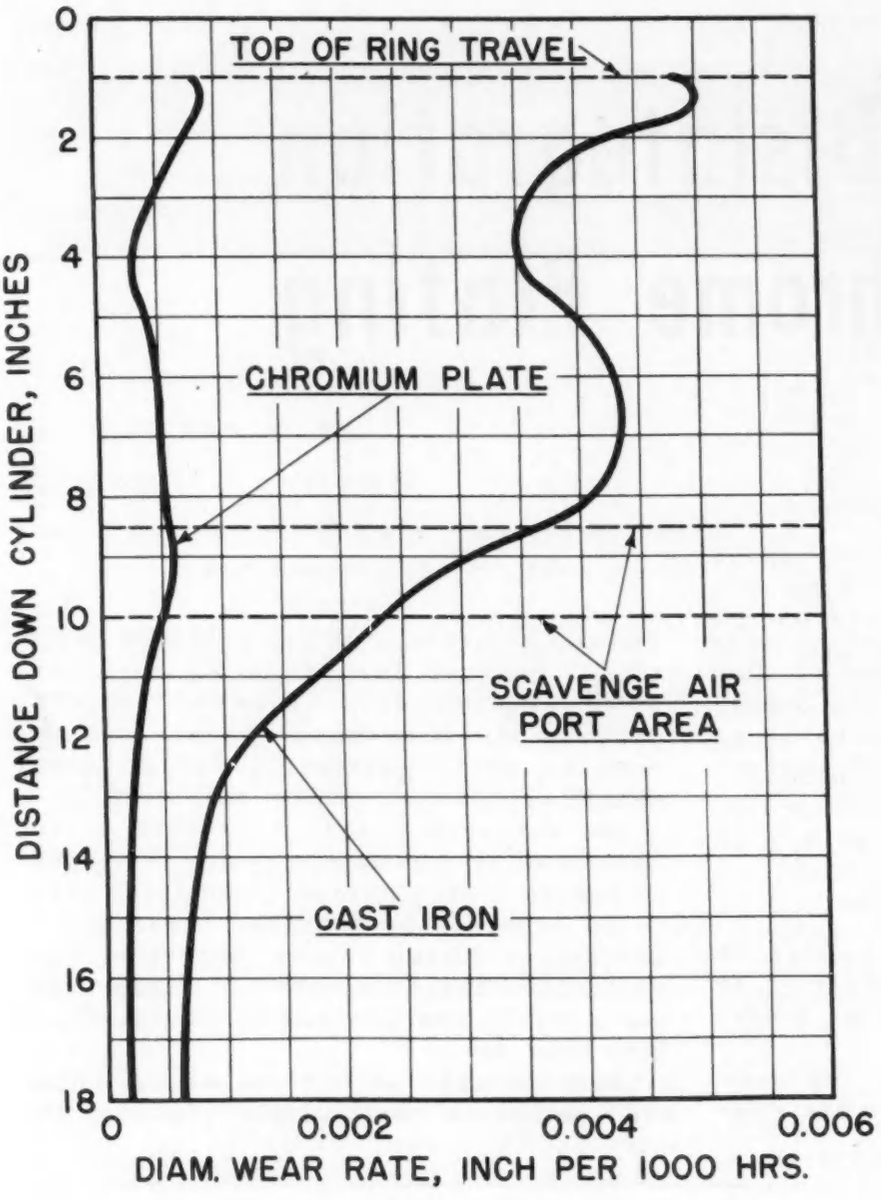
The chromium overlay seals the base metal, preventing breakdown of its surface or separation of any unbonded particles - whether formed during machining or during cast-iron growth. In fact, etching the base metal before plating removes most previously-formed smear material.

The chromium itself is etched during the porosity-forming process. This tends to remove highly stressed particles likely to separate by fatigue, shearing, or cavitation during engine operation. Adequate cleaning to remove all debris from porosity of the plating is necessary to keep wear low.

Chromium also is corrosion- and abrasion-resistant. With proper plating, the



•Fig. 1 - In each of six two-cycle diesel engines, chromium plating cut liner wear to one-quarter the rate with cast-iron cylinder liners



●Fig. 2 - Wear irregularity in the same engine decreases considerably with chromium plated cylinders. Wear rate shown is the average of five nonplated cast-iron liners with an average of 1015 hr operation compared to 10 chromium plated liners averaging 2610 hr operation

bond between the chromium and base metal, and within the chromium, prevents separation of chromium particles. The surface gets a high polish without loss of its oil-retaining porosity. Chromium plating produces a surface of smooth plateaux, even in height, of homogenous material, separated by lubricant-holding cavities. The smooth surface facilitates removal of excess lubricant, porosity provides for replenishment of the necessary minimum supply.

Fig. 1 shows average reduction of wear with chromium plating. The tests were made with six two-cycle diesel engines, ranging in size from 4 1/4 to 8 3/4-in. bore. Horizontal lines on the bar graph for each engine show average wear rate for from four to 41 cylinders. There are 92 nonplated and 104 porous chromium-plated liners included in the tabulation.

The average wear rate of 4 to 1 for all engines takes on real significance in terms of a quadrupled life expectancy because of the high number of nonplated cylinder replacements due to surface failure after short operating periods.

An interesting feature of chromium plating is smoothing of the cylinder's wear profile. Right-hand curve in Fig. 2 typifies extremes of longitudinal wear differences throughout a nonplated cast-iron liner. Sharp wear gradients make it difficult for the piston ring to follow

Questions and Answers

Seriousness of surface-disintegration wear and merits of chromium plating - from economics and performance standpoints - are among the points raised by some of the discussers. Below are some of these questions and the answers to them by authors Payne and Joachim.

QUESTION: Isn't surface disintegration an infrequently-found kind of wear?

ANSWER: It's more than occasional. Though blamed to accelerated production during the war, this kind of wear continues relatively unabated.

QUESTION: Don't liner composition and microstructure affect extent of scuffing or surface-metal smearing? It seems that materials having appreciable amounts of free ferrite, either as secondary ferrite or as ferrite associated with Type D graphite, can and do cause scuffing.

ANSWER: Liners used in the Naval Station tests were prescribed by engine manufacturers as best type for each engine. Inspection of both good- and bad-wearing liners showed close similarity in microstructure.

QUESTION: Isn't high initial cost the main drawback to chromium plating? Unless the engine operates from 6000 to 10,000 hr, plating isn't economical.

ANSWER: Plating increases liner life 400% for an additional cost of only 40%, in medium and larger sizes. Consider also foundry cost savings from elimination of rejections - generally considable - with complicated castings.

QUESTION: What really happens to plated-surface performance as the plate wears away and porosity approaches zero? Some say the liner continues to function satisfactorily; others report the wear rate climbs steeply; still others find the porous-free surface will quickly seize and score.

ANSWER: Chromium with all porosity worn away is still safe to use, provided it's worn in a very narrow band - as in the maximum wear zone at the top of the liner. Apparently the rings carry over oil from adjacent areas.

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the bore surface and maintain a gas seal. High-velocity movement makes the ring jump from the small diameter and hit the liner again near the top of the worn area. On the down stroke, the ring would hit the ridge with a sharp impact. This ring flutter accelerates ring wear and breakage, with poorer operating conditions accompanying blowby.

Wear profile of the chromium-plated liner, at left in Fig. 2 changes so slowly that no sharp ridges are formed. It's a comparatively gentle contour for the length of the piston-ring stroke.

An additional advantage with chromium-plated liners is that base material can be selected for strength, rigidity, cost, or other desired qualities without regard to wear resistance. Steel tubing can be purchased, eliminating present foundry casting rejections, providing a more suitable plating surface.

Paper on which this article is based also reports on the influence of 20 engine design factors and 10 engine operating factors on cylinder wear in 24 models of diesel engines. Complete paper is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

more on diesel wear

DIESEL ENGINE WEAR Laid To

BASED ON PAPER* BY

L. D. Thompson,
S. J. Backey and E. L. Conn

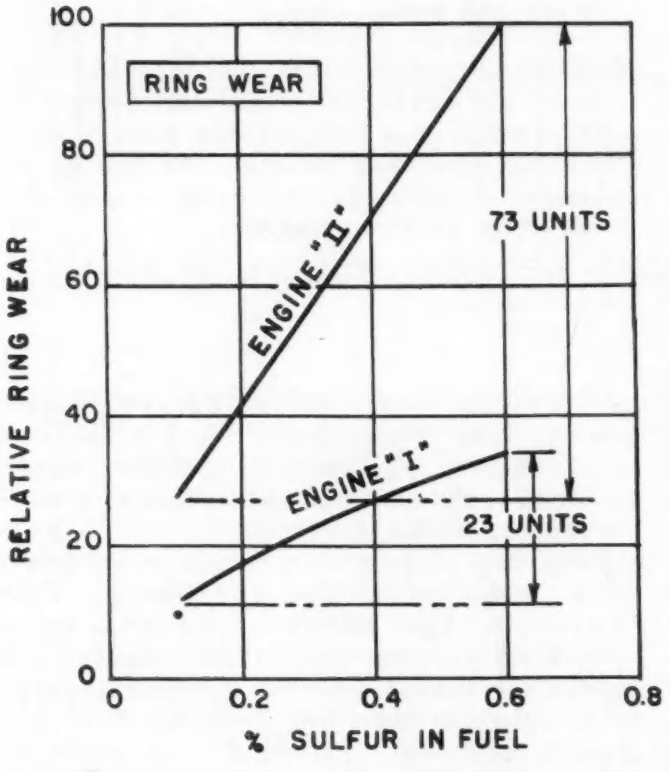
Research Engineers
FAIRBANKS, MORSE & CO.

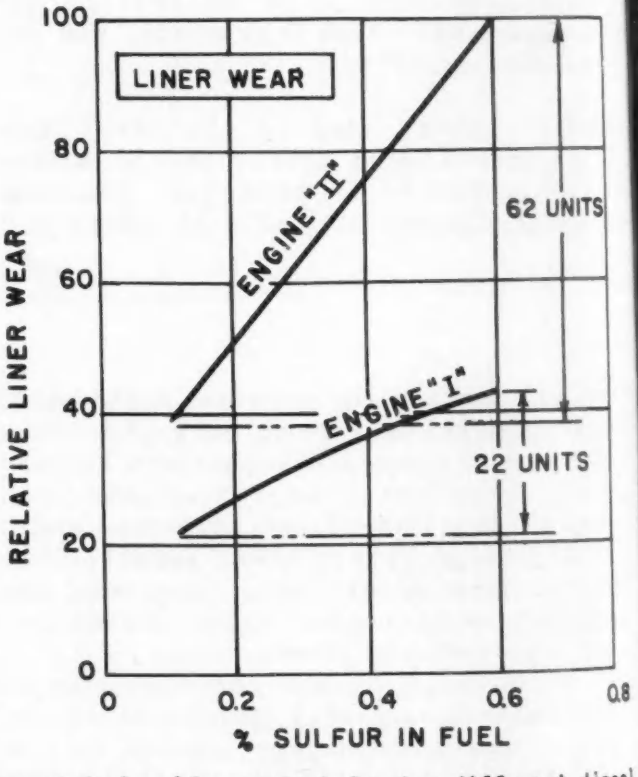
*Paper "Engine Wear Research," was presented at SAE Annual Meeting, Detroit, Jan. 15, 1948.

(This paper will be published in full in SAE Quarterly Transactions)

CURRENTLY POPULAR theory that sulfur in diesel fuel causes engine wear was confirmed by recent researches with five fuels in two different multicylinder engines. New thinking emanating from this work is that wear stems from sulfur-produced abrasive particles.

Sulfur content made considerable difference in the amount of carbon and





●Fig. 1 - Ring and linear wear charted as a function of fuel sulfur content for two different diesel engines. Engine I is a Fairbanks, Morse commercial, 2-cycle, conventional loop-scavenged, 5-cyl engine, with bore and stroke of 6 1/4 x 9. Engine II is an experimental 2-cycle, opposed-piston, 3-cyl engine, with 5¼-in. bore, 7¼-in. lower piston stroke, and 7¼-in. upper piston stroke. Tests with engine I were conducted at 70 bmep and 720 rpm; engine II was operated at 105 bmep and 1200 rpm

To Sulfur-Formed Abrasives

varnish deposited on pistons and cylinder bores. For example, there wasn't any varnish on liner bores after 500 hr of operation on a fuel with 0.08% sulfur. Another fuel, with 0.59% sulfur, coated an average of 20% of the liner surface with varnish.

Relative top compression ring and liner wear data for both engines plotted against sulfur content of the five fuels are shown in Fig. 1. Sulfur content was the only fuel property that showed correlation with wear. Wear index for these curves is based on 100 assigned to the highest wear rate, other values being prorated accordingly.

Extrapolating these data toward zero sulfur content shows very little wear can be expected. This was substantiated in development work on a dual-fuel engine. It was modified to operate on either oil or natural gas. With natural gas, only a small quantity of oil is used for ignition. Natural gas, having zero sulfur content, produced so little wear that tool marks were still visible on the top compression rings after 2,000 hr of operation at 76 bmep.

With sulfur established as a major producer of wear, next problem is to explain how it does so. We have a new theory on this "how," despite excellent work of others.

THEORY EXPLAINED

It arises from the observation that an engine, operating under heavy load conditions with normal jacket temperatures, shows more wear and deposits with higher

CONTINUED ON PAGE 61

Wear Theory Meets With Skepticism

Several discussers cast some doubt on the validity of the Thompson-Backey-Conn abrasion wear theory, leaning toward corrosion as a more logical explanation of wear stemming from sulfur in diesel fuels.

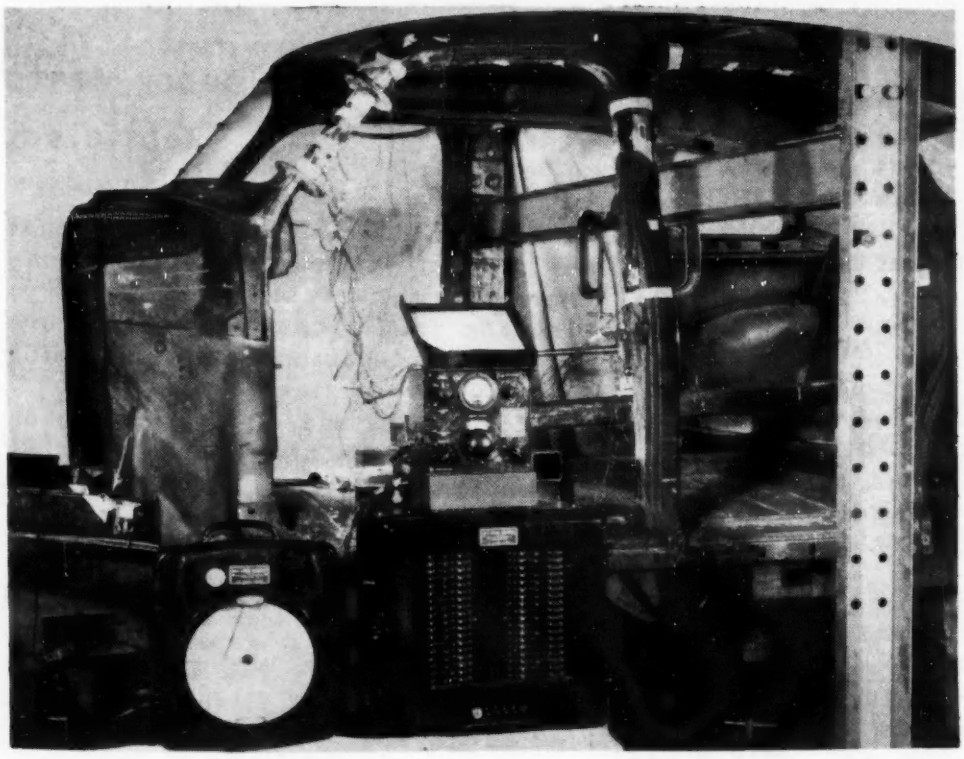
C. C. Moore and W. L. Kent, Union Oil Co., reason that sulfur wear is corrosive by nature. They say lubricating oils reduce wear at low water-jacket temperatures - a corrosive type since it becomes pronounced below condensation temperatures of moisture in exhaust gases. Same type oil reduces both low-temperature corrosive wear and sulfur wear.

Therefore, they continue, sulfur wear also is corrosive. It seems logical to them because sulfuric acid has a much higher condensation temperature than water. It could condense on, and corrode, cylinder walls and rings at much higher temperatures than water.

Wear stems from corrosion and destruction of oil's lubricating qualities as well as from abrasion, according to J. W. Pennington, Caterpiller Tractor Co. He sees lack of sufficient data to blame any one process for causing most wear under normal conditions. No test evidence, Pennington says, bears out this wear theory of abrasion by sulfur-hydrocarbon particles.

High sulfur fuels which cause deposits also increase mineral acid content of the lubricating oil. This accelerates corrosive action.

CAR BODY TESTING S



●Fig. 1 - Test set-up used in making strain gage tests on car body structure

(This paper will be published in full in SAE Quarterly Transactions)

CALCULATION of car body frame and component stresses would tie up the designer in N^{th} order mathematical manipulation because of varying moment of inertia and complicated sheet metal sections. But thanks to tests devised using tell-tale strain gages, the tension, compression, and bending load patterns emerge with less strenuous mathematics.

Strain gage readings taken in a static load test divulge magnitude of various loads and bending moments on a door opening frame. As shown in Fig. 1, gages are placed directly on the roof rail and center pillar. At the front pillar a tube is inserted in the windshield area, with strain gages applied to the tube.

Load increments are applied with loads located as in Fig. 2. Gage readings are automatically recorded at each load increment.

Fig. 3 shows the bending moment diagram around the door opening frame. Shaded area is drawn on the tension side. Be sides being subjected to bending, the front pillar is in compression and the center one in tension. Strain gages tell what these loads are.

Many body components also lend themselves to structural stress investigation. Typical is the front seat, diagrammed in Fig. 4. It lends itself well to structural analysis. Main cross members

Short-Cuts Stress Analysis

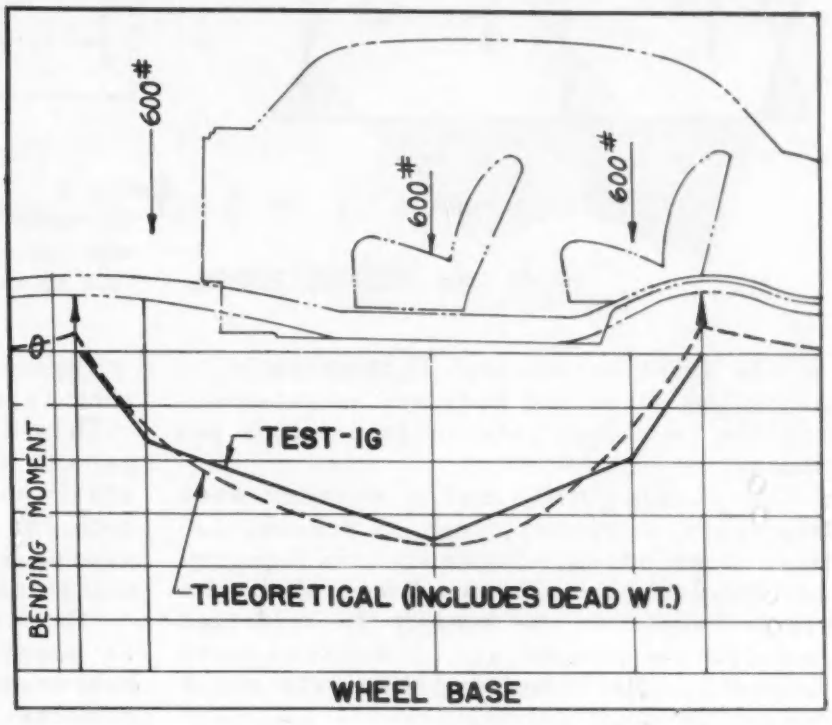
BASED ON PAPER* BY

Philip O. Johnson

and

Russell G. Heyl, Jr.

Fisher Body Division, GMC



● Fig. 2 - Diagram of body test loading, comparing testbending moment with theoretical one

are simple beams supported by seat adjusters. A 1000-lb, three-passenger load seems to be a good design assumption. It's considered to be uniformly distributed. A simple beam analysis tells the stress story.

The seat back acts as a cantilever beam. It takes its maximum load when the three passengers, simultaneously, brace their feet on the tow board, their shoulders against the seat back, while lifting the trunks of their bodies off the seat to adjust their overcoats. Strain gage analysis helped establish this design load at 1,000 lb.

Experimental stress analysis also is put to work after completion of the body design - for proof testing the body before it goes into production. The body is first twisted, then bent, given a torsional test, and finally a jacking test.

Twisting visually shows up any weak points. In the bending or beaming rig, deflection readings are taken to show how well body and frame are working together. This test reveals bending stiffness.

Next comes proof testing for torsional stiffness. The rear suspension is rigidly tied down and a twisting moment applied

*Paper "Stress Engineering as Applied to Automotive Bodies," was presented at SAE National Passenger Car and Production Meeting, March 4, 1948.

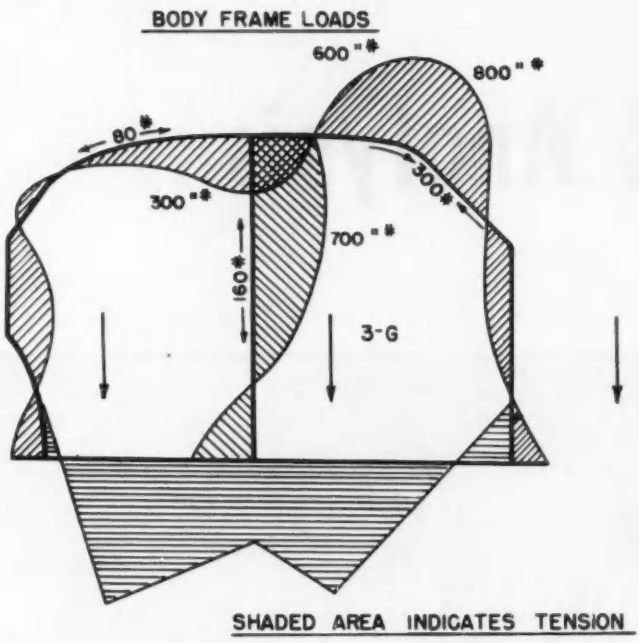


Fig. 3 - Typical bending moment curve around body door-opening frame due to bending loads

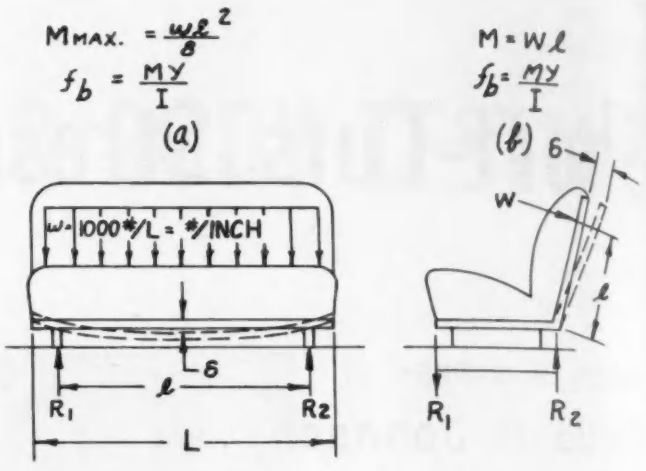


Fig. 4 - Structural and loading diagram of a front seat

at the front suspension. Deflection gages along the frame and body aid in determining the torsional rate in foot-pounds per degree.

The jacking test tells whether door openings are rigid enough to prevent too much distortion. Excessive deflection may bind doors or door locks when the car is jacked at the bumper. In this test the car is jacked as if a wheel were removed; deflections are read with gages around the door opening.

The car gets its final torture treatment in the road test.

This kind of structural analysis approach to body design produces a more efficient structure. It cuts costs for both car manufacturer and owner by eliminating excess weight from bodies, yet maintaining required strength rigidity.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

TOOL TEMPERING: Tempering tools by color prevents uniformity, says a division of the SAE Iron & Steel Technical Committee. It's not the modern way of doing it, these engineers and metallurgists say, strongly advising against it where proper equipment is available. Tempering an axe or chisel by color may do, but not a fine machine tool. Shops with no equipment must work out their tempering methods by trial and error. The worker becomes an artist at tempering, refusing to use a handbook. each new man must go through the same trial-and-error training period before he can handle the job. This isn't the case where proper controlled temperature equipment is on hand.

TRUCK FORMULA: Indications are that a complete analysis of vehicle performance - for finding the right truck or bus for the job - can't be reduced to single simple formula, according to studies of the SAE Classification and Evaluation of Transportation Engineering Formulas Committee. But the Committee does feel that graphical tools can be worked out so that nontechnical people can make the determination.

WHAT OPERATORS WANT in Cargo Aircraft

BASED ON PAPER* BY

John J. Casey, Jr. and R. Dixon Speas

Field Representative
New York

Assistant to the Vice-President - Engineering

AMERICAN AIRLINES, INC.

FIVE years of large-volume air cargo experience has taught the airlines what special features they need in an air cargo plane.

An aircraft designed specifically for air cargo use and embodying these features is a prime need of the air cargo industry. For carrying today's loads of dry goods, flowers, fruits, seafood, furniture, television sets, newspapers, heavy machinery, and livestock, the air cargo operators need

Operation dependability
Provision for higher loading density
Maximum utilization of space
Adequate means for cargo tiedown
Balance control
Temperature protection
Ease of loading

Operation Dependability - Already the armed services have conducted a number of successful all-weather cargo flight service tests. Airline experts agree that the equipment and procedures are adequately test-proved for controlled operations. Applied to commercial air cargo aircraft, all-weather flying aids would improve service to customers and would reduce operating costs through increased utilization of aircraft, flight crews, ground crews, and equipment.

Density - Design density of future cargo planes should be based on estimates of densities of probable loads. Leading cargo sales personnel have contributed the opinions shown in Table I on expected frequency of various commodities during the next five years. Their estimates point to demand for a loading density somewhere between the 5.1 lb per cu ft of converted passenger planes and the 18.8 lb per cu ft of the average railway express car.

Although average weight of postwar shipments has increased, density has dropped. This is due mostly to sales effort to promote shipments in the lower density ranges. Large mail order houses are shipping daily output by air to central points for local distribution.

*Paper "Cargo Aircraft Requirements," was presented at SAE National Air Transport Engineering Meeting, Kansas City, Dec. 1, 1947.

TABLE 1 - Estimated Frequency of Various Airborne Commodities, 1948 - 1953

COMMODITY	FREQUENCY									Density Ratio, lb per cu ft
	A	B	C	D	E[a]	F	G	H	Average	
Appliances (radios, toasters, washers)	6	3	5	3	5	7	2	10	5	9.0
Automotive and Aircraft Parts	12	6	5	14	22	9	5	10	10	37.0
Balloon Merchandise	1	7	2	2	2	5	½	15	4	4.0
Business Forms	2	1	3	5	3	4	½	1	3	5.0
Cut Flowers	12	8	12	3	7	10	1	5	7	4.9
Drugs and Pharmaceuticals	8	2	14	5	3	7	15	5	7	11.4
Fruits and Vegetables (fresh)	10	21	1	3	3	10	5	5	7	15.0
Furniture	8	1	8	-	1	4	1	1	3	8.5
Heavy Miscellaneous Machinery and Hardware	4	7	1	2	6	3	12	1	5	50.up
Livestock	2	1	3	-	4	2	10	1	3	3.0
Publications	5	2	3	15	10	8	17	10	9	35.0
Radio and Electronic Parts	10	3	4	4	5	5	18	10	7	17.0
Seafood	5	4	2	8	1	3	2	5	5	10.0
Wearing Apparel (men's)	5	7	17	5	6	6	1	1	6	9.0
Wearing Apparel (women's)	10	12	20	25	4	16	8	20	14	3.0
Plastics and Recordings	-	2	-	-	1	-	-	-	0	9.3
Miscellaneous	-	13	-	6	17	1	2	-	5	6.0

[a] *Actual frequency for month of April 1947*

The fashion industry has doubled its volume of air shipments. Further changes are likely as other industries switch to air freight.

Interior Arrangement - Although fixed bins are useful for small-package and multistop operations because they permit sorting en route, air freight operators, who carry large shipments with fewer stops, do not want fixed bins. They prefer to use roll paper or gummed tape instead for segregating shipments according to destination.

The temporary barriers permit solid loading - which is the best utilization of space - and they accommodate day-to-day variations in percentages of load to different destinations.

Fixed bins require an aisle through the cargo compartment, which is a further space penalty. Where bins are provided, the aisle need not be wider than 24 in.

Operators want a smooth floor surface so that hand trucks and heavy crates can be moved easily in any direction. Plywood floors 3/16-in. thick have been very satisfactory as long as they are in good condition. They are light, good protection for the metal floor underneath, and easy to replace. Further investigation might turn up an even better flooring.

The floor structure itself should have a load capacity of at least 200 psi.

NEED IMPROVED TIEDOWN RINGS

Cargo Tiedown Provisions - In any cargo plane, there must be provision for preventing shifting of the load during takeoff acceleration, vertical gust loads, turbulent air in flight, and impact on landing. If the ship is designed to withstand a vertical gust load of 3g, there should be enough tiedown points to hold the maximum payload in place against this force.

Strong, conveniently located tiedown points are a must. Experience shows that tiedown points should be located around

the perimeter of the cargo floor with a grid of fittings spaced not more than 2 ft apart in all directions. Cargo tie rails should be located at the one-third, two-third, and peak lines of the sidewall.

Present tiedown rings are unsatisfactory. Deformation has resulted where excessive loads have been applied to one ring, and other damage has resulted from the weakness of the rings.

In a new design, about 20% of the tiedown rings should be able to withstand applied loads of 3000 lb in any direction. The remainder should be able to withstand 500 lb horizontally and 1000 lb vertically.

A snap open-shut ring fitting would be better than today's swivel rings, which require that tiedown ropes be run through each fitting. Tiedown fittings located in the floor should be recessed to prevent tripping and interference during loading.

Fore and aft movement of the cargo can be prevented by a strong bulkhead at the forward end and rope cargo nets at the aft. The tiedown fittings serve also as attachments for the nets. If the load does not extend to the ceiling of the compartment, the top section of the net can be pulled forward over the top of the load and attached to the top tie rails. The same method can be used to secure the forward end if the strong bulkhead entails too much weight.

The same nets can be used to control loads too dense to be loaded solid. Fig. 1 shows the nets holding down 10 tons of grapes in a DC-4. The nets are 10 ft long and 20 ft wide. Forged steel rings are spliced into the end of each rope. On one side of each net, rings spaced at 2-ft intervals allow for variable load densities. At the other side, the nets are fixed to a steel cable running the full length of the compartment. Cargo aircraft should be equipped with hooks, cleats, or shock chord attachments in the ceiling area so that the nets can be hung up out of the way during loading.

Variation in length of load can be accounted for by varying the number of nets used. If ends of adjacent nets are hooked to each other, nets aft of the load may be detached and suspended from the ceiling or rolled up at the side of the cabin.

The nets are useful too in transportation of livestock. Cows have been flown in stalls constructed of magnesium tubing and plywood, with the cargo nets used for gust protection. A load of 252 sheep and four sheep dogs traveled safely inside a wooden framework covered by the nets.

Balance Control - From the operators' viewpoint, the best location for the airplane's center of gravity is at the center of the cargo loading area, and the wider the allowable center-of-gravity range, the better. If cargo can be loaded according to destination instead of as balance considerations dictate, throughstop loading times are cut. To spread center of gravity limits and increase flexibility of cargo distribution, cargo planes need aerodynamic balancing tabs, V-tabs, or some similar device.

CARGOS KEEP WITHOUT COOLING

Temperature Protection - More than 75% of the anticipated air cargos tabulated in Table 1 do not require temperature control, but until air cargo demand increases sufficiently to support segregation of perishables into special airplanes, it will be desirable to have all cargo planes equipped with heating, insulation, and some refrigeration.

The heating-insulation combination should be capable of maintaining cargo cabin temperatures of 60F with outside air temperatures down to -40F. Refrigeration is not considered so important now as it was a few years ago because, in the meantime, air cargo operators have found that most fruits and vegetables can stand flights of the few hours needed to span any two points in this country in today's DC-4's and C-46's without refrigeration. Precooling of produce and aircraft before take-off plus low outside air temperatures minimize the preservation problem.

One factor which may make refrigeration imperative is the increased demand for transportation of frozen foods. Even with precooling and control by outside temperatures, ground, climb, and descent times will have to be protected by refrigeration or else by extensive insulation.

When demand for transportation of non-

perishables increases to the point where nontemperature-controlled aircraft are justified, there will be many savings in using them. Payload will be increased 5% for a 19,000-lb-payload airplane such as the DC-4; aircraft purchase price will be cheaper; and maintenance costs lower.

WANT LARGE, LOW DOORS

Loading Requirements - Ease of loading calls for the cargo compartment floor to be at truck level and for a number of loading doors.

Wherever cargo is handled, the truck is the general vehicle used for local collection and distribution. Truck-level loading doors would cut down on expensive loading equipment and speed the job. Capital investment could be concentrated in docks and storage facilities at major terminals where volume of cargo justifies the expense, instead of being scattered in expensive loading equipment at each stop.

It would be desirable to have enough openings into the cargo compartment to permit completion of unloading and loading during the time the plane is stopped for routine servicing. One door should be located at either the front or the rear end of the cargo compartment, with other doors spaced to give access to the rest of the compartment.

There should be at least two large doors for a 20,000-lb cargo plane and four large doors for a 40,000-lb plane. The large doors should be at least as large as those on the DC-4 air freighter - 95-in. wide by 67-in. high. Experience shows that the number of shipments which fail to pass through these doors is less than 0.1% of all loads. Enlargement of the doors to a width of 120 in. and a height of 72 in. would accommodate most loads refused because of door size.

Large cargo doors should open upward and outward. Small doors can be hinged on the side. They should be mounted on extended hinges to minimize interference during loading.

All doors should be located so that trucks can back into the loading position without encountering any part of the plane or interfering with each other.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

● Fig. 1 - Load of 10 tons of grapes loaded at Lodi, California for Columbus, Ohio. Note tiedown rope nets and tiedown rings.

DEVELOPMENT of BIGGER RAMJETS Awaits Combustion Data

BASED ON PAPER* BY

W. H. Goss and Emory Cook

Applied Physics Laboratory
The Johns Hopkins University

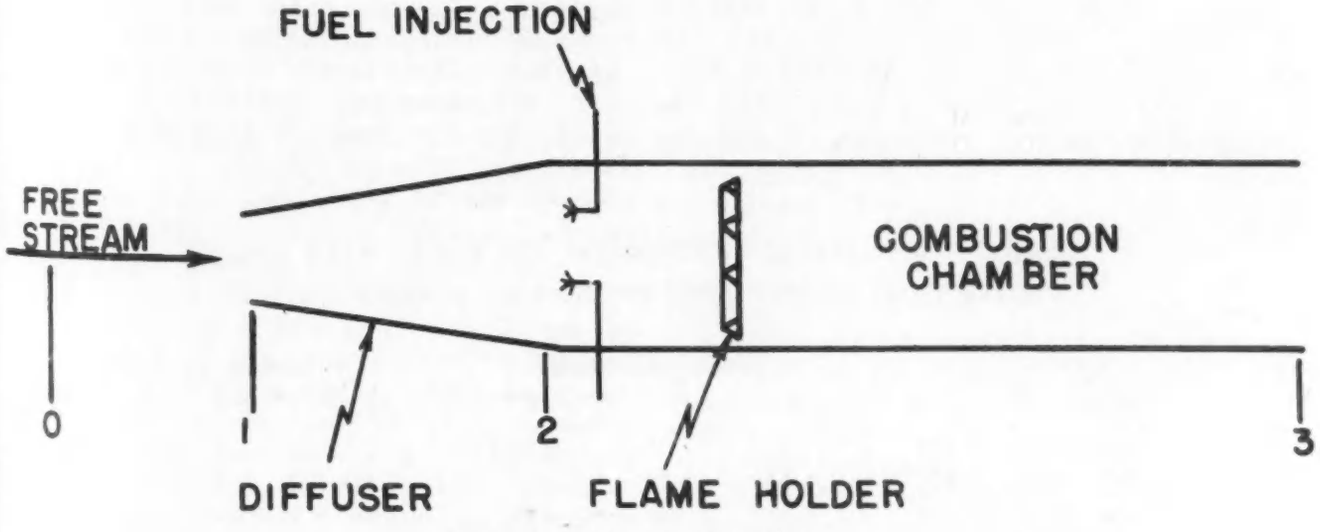
(This paper will be published in full in SAE Quarterly Transactions)

UNLESS developers of supersonic ramjets can take over the power facilities of Hoover Dam, the challenging problems of this new powerplant will have to be solved by brains instead of brawn.

Combustion problems more than compensate for the ramjet's mechanical simplicity. Although solution of the problems will require plenty of power-consuming research into the fundamentals of aerothermodynamics, the problems are worth solving because the supersonic ramjet is unsurpassed for military applications demanding high speed on a one-way trip.

It's easy enough to build a ramjet - as Fig. 1 shows, they consist mainly of

*Paper "The Ramjet as a Supersonic Propulsion Plant," was presented at SAE Annual Meeting, Detroit, Jan. 15, 1948.



•Fig. 1 - Diagram of ramjet

a divergent diffuser and a straight-sided burner - but it's not easy to supply the air for testing the burner. It would require between 564,000 and 1,720,000 hp to supply air for full-scale sea-level testing of the burner of a ramjet 4 ft in diameter at a Mach number of 3, researchers calculate. Figures like these convince them that the combustion engineer will have to gather experimental data on small-scale apparatus or under simulated altitude conditions, extrapolate it for full-scale design, then use flight tests for confirmation. Right now developers of the ramjet are busy with the first of these three steps.

Why data must be gathered on very small models at low Mach number or at very-high-altitude conditions can be seen from Table I. It lists airflows needed to simulate flight conditions for a burner of 1 sq ft cross-section with no exhaust constriction and an assumed internal drag loss of one atmosphere. The two values of airflow correspond to two values of stagnation pressure - one for plane shock and the other for isentropic recovery. They represent the extremes in diffuser design.

Laboratory equipment for supplying the pressures and flows needed to simulate sea-level sonic burner inlet conditions for a model of even the moderate 1 sq ft size is not available. Sea level testing must be done on even smaller models.

The only alternative to developing ramjets for low-speed low-altitude flight would be to boost the ramjet up to cruising conditions with an independent powerplant - and that's too difficult.

Existing equipment can provide airflow for high-altitude conditions. And the fact that exit choking phenomena completely separate the regime within the combustion chamber from that in the exhaust chamber makes it easy to simulate flight conditions at the burner exit. Instead of reducing the exhaust chamber to altitude pressure, it is necessary only to reduce the pressure to a value slightly below the critical pressure of the sonic exhaust.

The higher the simulated flight Mach number, the higher will be this critical pressure for a given simulated altitude. At a value about M = 3 for an intake condition simulating an altitude of 60,000 ft, it becomes unnecessary to reduce exhaust chamber pressure at all. The critical pressure is then above sea level atmospheric pressure, and the combustion chamber regime exhausting into the atmosphere exactly reproduces the high-altitude burner exhaust flight condition.

DIFFUSER SIMULATES FLIGHT

In actual flight, a diffuser ahead of the combustion chamber intercepts the supersonic stream and slows it to sonic velocities. Omitting the diffuser and reproducing only the subsonic burner entry conditions may introduce two sources of error: Direct coupling may produce resonance oscillations, and the curve of back pressure buildup versus mass flow variations is not the same in a connected-pipe intake as in a free-flight intake.

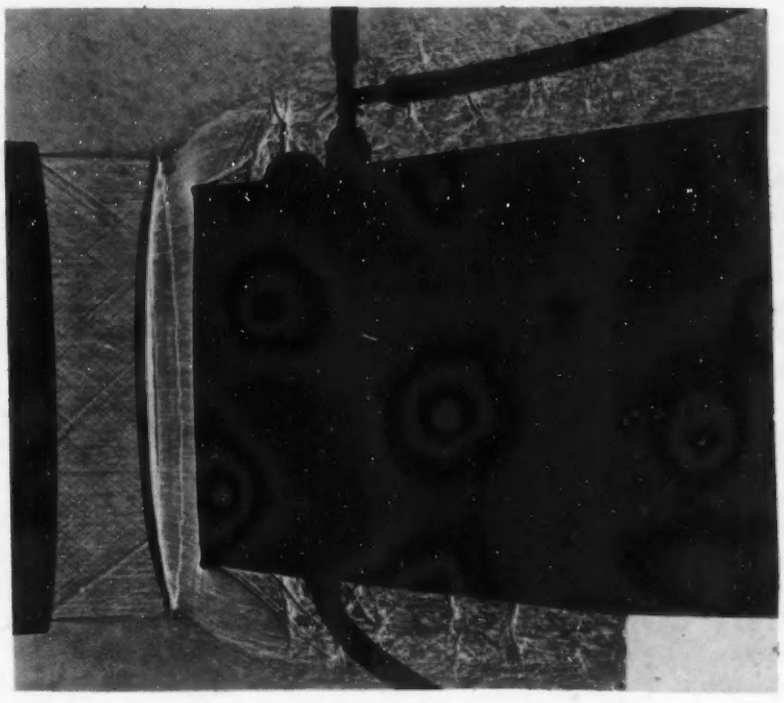
Adding the diffuser to the test setup and providing supersonic flow is the only way to duplicate flight conditions at the burner inlet exactly. Only the intake area need intercept the supersonic stream - it is not necessary to immerse the entire ramjet in the supersonic stream. The fact that the exhaust pressure is lower

TABLE 1 - AIR INTAKE REQUIREMENTS FOR RAMJET WITH 1 SQ FT COMBUSTION CHAMBER AREA AND NO EXIT CONSTRICTION

			Isentropic Intake		Single Shock Intake	
Mach No.	Altitude, ft	T_s, F	P_s, lb per in^2	M_a, lb per sec	P_s, lb per in^2	M_a, lb per sec
2	SEA LEVEL	477	115	110	83	80
3	SEA LEVEL	1000	540	520	177	170
2	60,000	248	8.2	7.9	5.9	5.7
3	60,000	640	38.6	37	12.7	12.2

than that of the supersonic stream does not matter because the exhaust pressure will surely be below the critical pressure.

This technique of testing with the diffuser requires only a little more mass flow than if the flow were supplied directly to the burner. The free supersonic jet can be obtained by expanding air from stagnation pressure to ambient through a supersonic nozzle.



●Fig. 2 - Diffuser intake placed in supersonic free jet. Detached plane shock is characteristic of spillover regime

Fig. 2 pictures the technique. Plane shock is shown standing off in front of a simple divergent inlet during spillover conditions. This happens to be a marginal application of the principle; the jet is too small in comparison to the intake to allow complete isolation of the intake in the supersonic stream. However, checks in a larger stream have shown the error to be of second-order importance.

Aerodynamic effects of spillover at the intake and the interaction of the exhaust jet with external flow are problems which can be studied in supersonic wind tunnels because very small models will give usable results. (Possibility of studying ramjet combustion problems in supersonic wind tunnels is remote because test sections must be 10 or 12 times the diameter of the model. Present tunnels of only 2- or 3-ft diameter are rare and costly.)

When enough testing has been done with available facilities to give an understanding of the fundamentals of the aerodynamic and combustion processes, the knowledge can be applied to extend ramjet sizes and speed ranges beyond those where laboratory testing facilities on full-scale units become impractical. This bootstrap method is the surest and cheapest way to lift ramjet development out of the initial stage of merely trying to get something that works.

Flight testing must be the final check on scaled-up units. Already there has been intense development of telemetering devices. A typical installation records diffuser exit static pressure, diffuser throat static pressure, total free stream pressure, fuel flow rate, wall temperature at exhaust, and fuel supply pressure.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

SAFETY and OPERATIONAL

A year's intensive testing of the reverse-pitch propeller in actual transport operations has indicated that this development is the biggest improvement in operating mechanisms for transport planes since the installation of windshield wipers in 1940.

Application of reverse thrust has meant increased safety, because shorter runways are needed, emergency stopping facilities are thus provided in case of brake failure, and increased ability to stop on wet and ice-covered runways is gained. Other advantages include decreased tire and brake wear and the possibility of lower brake requirements for emergency brake systems.

These advantages are not being gained, of course, without the solution of a number of problems. Matters that have come up for consideration include:

- Operating requirements.
- Throttle operation.
- Carburetor troubles.
- Service difficulties.
- Passenger reaction.
- Performance credit under C.A.R. transport category.

OPERATING REQUIREMENTS

The general requirements for operation of a reverse-thrust mechanism have been resolved as follows:

1. The reversing process must be under the direct control of the captain, but he must be able to actuate the reversing mechanism without moving his hand from the throttle.

2. The plane must be protected against inadvertent operation of the reversing mechanism while in the air.

3. Immediately upon contacting the ground, the mechanism must automatically allow the reversing operation to be performed.

4. A mechanical override must be included to allow operation even when the automatic release fails.

Thus, additional movements must not be required of the pilots during landing, when they are already at the peak of their operational duties, but they must be able to take over if the automatic mechanism ever fails.

The reverse-thrust mechanism for the DC-6 was designed with these principles in mind. Its operation is as follows:

As soon as the plane contacts the ground a microswitch operated by the landing gear automatically releases a solenoid-actuated lock in the throttle mechanism, and allows the throttle to be pulled back of the forward idling position. Pulling it back 8 deg contacts the actuating switches, which reverse the propellers. Further rearward motion of the throttles then applies engine power to give the necessary thrust for aerodynamic braking.

Two microswitches are used: one on the oleo strut of the right-hand landing gear and the other on the nose wheel. These switches are connected in parallel, so that when the oleo strut of either wheel

GAINS SEEN FOR REVERSE-PITCH PROPS

BASED ON PAPER* BY M. G. Beard AMERICAN AIRLINES, INC.

compresses 3/4 in., contact is made in the microswitch, which actuates the solenoid throttle lock.

Two microswitches are necessary because in a normal landing the tire takes the major portion of the deflection, allowing a time delay until the main landing gear oleo strut compresses sufficiently to operate the switch. By this time the air speed has dropped so much that the major value of potential aerodynamic braking is lost.

If a fast, 3-point landing is made or if the nose wheel is shoved forward onto the runway immediately, and the aileron rolled hard right to depress the right wing, it is possible to compress the right oleo strut the required amount to obtain reverse pitch quickly, but under many conditions such maneuvers are not practical. With the two switches, however, reverse thrust can be obtained immediately after ground contact is made, whether a 3-point landing is made or the nose wheel contacts the runway first.

The mechanical override that is being incorporated in DC-6's consists of an indicating flag, which must be manually raised to release the solenoid throttle lock. This flag is in a location where inadvertent operation is impossible.

THROTTLE OPERATION

When the DC-6 was being designed, there were some interesting discussions as to whether a simple, forward-operating throttle should be used or whether reverse-thrust actuation and power application should be made by a rearward motion of the throttles.

There is much to be said for the normal, forward-opening throttle to obtain reverse power. There is only one motion to remember whenever power application is required and there is no ambiguity as to what motion to make when reverse thrust is desired after the pilot becomes accustomed to the system. There are thousands of motions used safely that have no relation to the desired motion of the mechanism being operated. The most common, perhaps, is the automobile gear shift. Forward low gear is obtained by pulling the shift lever to the rear and reverse motion by pushing the lever forward. Both of these are directly opposite to the desired motion of the car, yet even the most unmechanically minded woman learns to operate them instinctively.

The rearward motion is logical in that it is the direction of the motion or deceleration desired, but it complicates the throttle mechanism, which adds to

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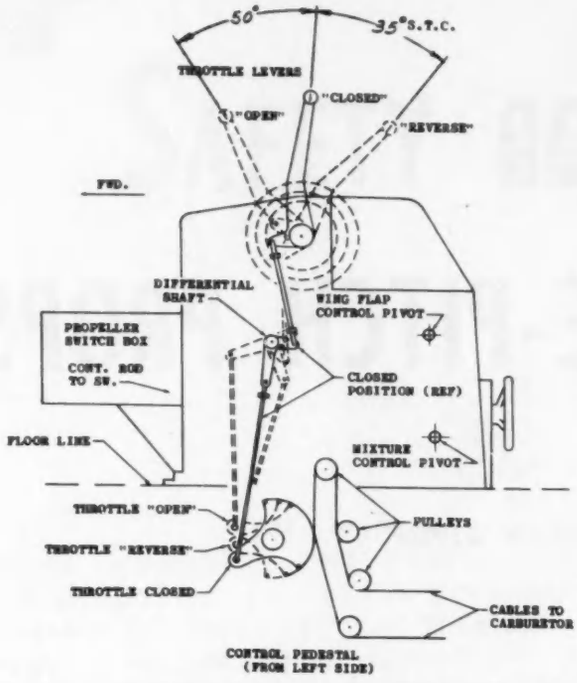
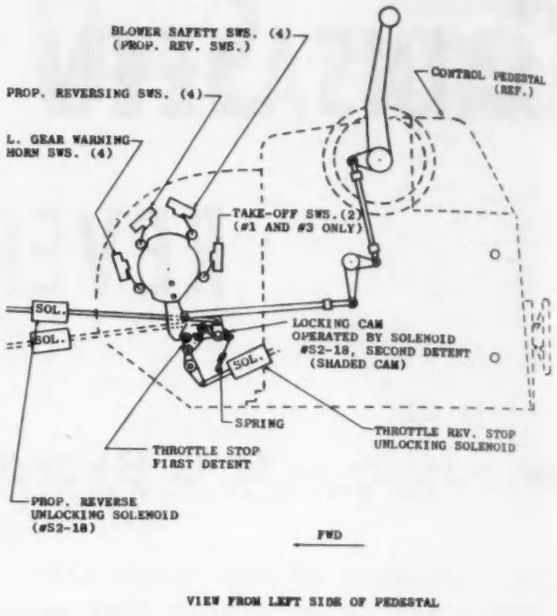
*"Practical Aspects of Reverse-Thrust Propellers in Airline Operation" was presented at the SAE Annual Meeting, Detroit, Jan. 15, 1948.



●Fig. 1 - Schematic diagram showing throttle-control linkage

Note - Differential shaft shown is #2 throttle. #1 differential shaft is forward and #3 and #4 shafts are to rear of shaft shown above.


BLOWER SAFETY SWS. (4) (PROP. REV. SWS.)
CONTROL PEDESTAL (REF.)
PROP. REVERSING SWS. (4)
L. GEAR WARNING HORN SWS. (4)
TAKE-OFF SWS. (2) (#1 AND #3 ONLY)
SOL.
SOL.
SOL.
LOCKING CAM OPERATED BY SOLENOID #S2-18, SECOND DETENT (SHADED CAM)
SPRING
THROTTLE REV. STOP UNLOCKING SOLENOID
THROTTLE STOP FIRST DETENT
PROP. REVERSE UNLOCKING SOLENOID (#S2-18)
FWD
VIEW FROM LEFT SIDE OF PEDESTAL

●Fig. 2 - Schematic diagram showing propeller-reversing and throttle-stop microswitch

both maintenance and rigging costs of the plane. In addition, because of the physical limitations of the pilot's reach, it becomes necessary to shorten the throttle arc for forward power application and to place the throttles in an awkward operating position at the extreme rearward full-throttle position. This requires an extremely precise throttle mechanism to compensate for the increased sensitivity of throttles through the rearward motion.

Figs. 1 and 2 are schematic diagrams of the mechanism required in the DC-6 to accomplish all the automatic functions of the rearward-moving throttle. Fig. 2 shows the reversing-switch cam and locking mechanisms with actuating solenoids that are required to accomplish in correct sequence the various functions that occur as the throttles are pulled rearward from forward idle position. It also shows the various safety locks and releases required when the automatic throttle release is actuated by the landing gear solenoid.

Probably more important than which direction of throttle operation is used is standardization of the motion for all planes. Thus, once having started with the reverse throttles, the die was cast, and all models must be designed with the same direction of motion. Unless some major operating fault is uncovered with reverse throttles, it is doubtful that the direction of throttle motion for reverse-thrust actuation will ever be changed.

CARBURETION TROUBLES

If the mixture controls are left in the autorich position and low power in reverse is used to land a DC-6 at El Paso, Mexico City, or any airport where density altitudes are above 3000 ft, one or more engines will promptly die. The difficulty lies primarily in the idle mixture adjustment of the conventional carburetor, which is mechanically linked to the throttle opening so that a fixed amount of fuel passes through the idle jet for any given throttle opening over the idle mixture range, irrespective of the quantity of air entering the engine. The idle

jet affects the mixture through 30% of the throttle motion from idle to take-off position, the effect tapering off as the throttle is opened. The idle adjustment is a compromise of several conditions of operation. For these operations, it is necessary only that the engine continue running and that the mixture be good enough to allow rapid acceleration in conjunction with the acceleration pump as the throttle is opened. Until reverse-thrust props were installed there was no necessity for greater refinement.

Because of the geographical location of airlines maintenance bases, idle mixture adjustments are usually made at altitudes below 2000 ft. As long as the airplane is operated at the approximate altitude at which the adjustment was made, the richening effect on carburetor mixtures for any given throttle setting in reverse thrust is not sufficient to cause the engine to die if throttles are allowed to remain at low throttle setting during the reverse-thrust operation on landing. As the altitude of the runway increases, however, the carburetor mixture over the range affected by the idle jet becomes increasingly rich, with a corresponding reduction in engine power for any given throttle setting through this range and with a consequent increasing tendency for the engine to die. In practical operation it has been found that when idling mixtures are set at sea level, a density altitude of over 3000 ft will cause critical engine operation if throttles are not advanced beyond the position where the idle-mixture effects have considerable influence on the overall carburetor mixture.

At any given altitude there is an engine rpm and relative throttle position for reverse-thrust operation above which the engine will not die from rich mixtures. Thus, the throttle quadrant is being provided with a landing reverse detent. When the throttle is in this position, the rpm is high enough to prevent the engine from dying while the propellers are reversed for landing.

For the DC-6 at density altitudes up to about 7000 ft, about 1800 rpm with airplane stationary on the ground will normally meet this requirement for carburetors having idling jets set for sea-level operation.

At higher-density altitudes, however, satisfactory engine operation is not obtained, even when the throttles are pulled back beyond the 1800-rpm position with the propellers in reverse pitch. For this reason, compensated idling jets must be developed and installed on the carburetors of planes equipped for reverse-pitch operations.

SERVICE DIFFICULTIES

The main service difficulties that have been experienced since the first experimentally licensed DC-6's were put into operation in December, 1946, are:

1. Failure of propellers to reverse on landing.
2. Failure of a propeller to unreverse.
3. Propeller abrasion.
4. Obstruction of windshields by snow when using reverse thrust while operating on snow-covered runways.

The few instances of failure of propellers to reverse have been caused either by failure of the landing gear microswitch, by sticking of the throttle reverse lock solenoid, or by failure of the pilot to put sufficient rearward pressure on the throttles to unlock the solenoid actuating the reverse stop. Some difficulty has also been experienced from open-type normalizing relay contactor points fouling from dust accumulations. Seal-type relays are definitely indicated.

Ten instances have occurred in a year's operation when propellers failed to unreverse after reverse thrust had been used. All were discovered and corrected before take-off. This brings up the question of whether it would be possible for the pilot of a 4-engine plane to complete a take-off without noticing that the propeller was in reverse pitch. During taxiing in calm-wind conditions, eccentric thrust tends to turn the plane off the the taxi strip, but in strong crosswinds, the eccentric thrust might not be recognized. Head temperatures are always high after long taxiing with reverse thrust, however, and this condition should be noticed by the pilot. Assuming, further, that engine runup is done with brakes locked, it would be possible at night on dry runways for the pilot not to notice the direction of thrust during runup. The

● Fig. 3 - Hollow steel blades after a series of reverse-thrust operations using high power

rpm on runup in reverse pitch, however, is lower than with the normal low-pitch setting of the prop blades, and this immediately indicates trouble to the pilot. Also, with the Curtiss propeller, there would be no response to governing action when the master propeller control operation was checked during engine runup.

Any one of these indications would cause the pilot to discontinue the take-off shortly after reaching the take-off throttle position. Tellites indicating when the propeller is in reverse pitch are being installed on the DC-6 in a position where they will be visible by the flight crew.

Propeller abrasion with reverse-thrust operation is considerably more severe than under normal operation, even on the steel-bladed Curtiss propellers that have been used for most reverse-thrust operation. When propellers are reversed on landing and high power is used, a small cyclone of light debris, cinders, and pebbles is set up. These particles are driven against the propeller, causing considerable damage, as can be seen from Fig. 3, which shows the tip of a steel blade after 50 reversals on a coral surface runway. Even the chromium plating of the blades has not been an entirely satisfactory method of coping with this abrasion, as wherever the plating chips off, the exposed steel starts to rust. As a temporary measure, blades are being periodically painted with ANC-52 compound to seal them against rust at abrasion points.

Clean, concrete runways should also prove helpful. In fact, if this type of runway were used throughout a system, abrasion might be negligible, even on dural blades.

Propeller rubber deicer shoes have suffered severely from abrasion nicks, especially the electrically heated ones, where deep nicks usually cut the wire elements and upset the electrical balance of the propeller deicing system, necessitating replacement of the shoes. Long coverage shoes are being replaced with a shorter type covering about 30% of the length of the blade. Unfortunately, not much service experience has been gained with them, as they were in the process of installation at the time the DC-6 was temporarily withdrawn from operation in November, 1947, but abrasion difficulties have definitely been reduced with these shoes. In the long run, the indications are that propeller electrical heating elements must be incorporated within the structure of the propeller blade or protected by abrasion-resistant material in order to have satisfactory operational life.

When reverse thrust is used on runways covered with light snow, the snow tends to blow ahead of the airplane, thereby obstructing the forward vision of the pilot. This condition has not yet been observed sufficiently to indicate to what

extent power application can be used in stopping and still obtain good vision of the runway ahead. More information on winter operations is also needed to determine the stopping ability of airplanes on icy runways when nose-wheel steering is weak or useless, in case of landing with unsymmetrical power when one engine is dead. This should not be too difficult on a 4-engine plane, but it might be on a twin-engine ship. It is also necessary to find out what control the pilot has in keeping the airplane straight down an icy runway by the use of reverse thrust under severe crosswind conditions.

PASSENGER REACTION

Passenger reaction to reverse-thrust propellers has been uniformly favorable. It was feared at first that the increase in engine and propeller noise on power application after reversing would alarm the passengers, as this crescendo frequently sounds as if a pullout is being started. It was found, however, that as long as power is applied so as not to exceed 25-28 in. manifold pressure, the sound level in the cabin is not alarming to the passengers.

PERFORMANCE CREDIT

The possibility of using reverse thrust to obtain shorter runway lengths for landing or for obtaining greater landing gross weights for given runway lengths under the T category has always been intriguing to the engineer and the operator. Although winter experience is largely lacking, reverse-thrust operation has gone through sufficient service trial so that in the near future it seems that the airlines and the manufacturers will be in a position to request some credit under the T category for the installation of reverse-pitch propellers.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

Diesel Sulfur Wear

CONTINUED FROM PAGE 45

sulfur fuels. It's possible that sulfur combines in combustion reaction with hydrocarbon molecules to form a black abrasive product - similar to synthetic rubber hardened by addition of sulfur in the vulcanizing process. Thus, these abrasive deposits cause most of the wear.

At least four general observations support this theory. They are:

1. People using home burners find that high sulfur fuels produce considerably more deposits in their furnaces and stacks. In this case there is no lubricant for the sulfur to react with.

2. In the standard wick test for illuminating oils, more deposits form on the chimney with higher sulfur fuels. Here again there is no lubricant. Only data available on this wick test are for light oils; heavier oils cannot be burned in standard wick test equipment.

3. Analysis of black deposits found in the center of the combustion chamber, on top of the pistons (where there's little likelihood of lubricant contact), shows essentially the same percentage of sulfur - 1 to 3% - regardless of the fuel's sulfur content. Exhaust port deposits also contained the same percentage of sulfur.

This may indicate the black product formed in combustion is a hydrocarbon content containing a maximum of 3% sulfur when saturated. Therefore, higher sulfur fuel allows greater quantities of the same product to form.

4. Tests showed that high wear accompanies high deposits.

Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.

Summer Meeting Dinner Speakers' Table - (left to right) Past-Presidents C. E. Frudden, L. Ray Buckendale, Mac Short, Ralph R. Teetor, W. B. Stout, Dr. H. C. Dickinson, J. H. Hunt; Dinner Speaker Wilbur Shaw and SAE President R. J. S. Pigott

CONTINUED FROM PAGE 17

cars in automobile racing. . . . at speakers table peopled by a majority of the living past-presidents of SAE. Extra-curricular activities included the Sam Dickey-directed field day and the usual formal and informal golf tournaments and matches.

FUEL-ENGINE Problems Engage Engineers At Car, Truck, Fuel Sessions

MORE emphatically than ever industry's theme seems to be, "Let's better the vehicles and their performance, yet make them less costly to produce, cheaper to operate." This challenge of higher standards and lower costs is being met by ingenious ways of getting more octane numbers as well as in ignition, materials, engine, and steering developments.

Based on 12 papers and discussions, presented at one Passenger Car, one Body, one Truck & Bus, one Materials, two Transportation & Maintenance, and two Fuels & Lubricants sessions, under chairmanship of E. S. MacPHERSON, W. B. STOUT, L. RAY BUCKENDALE, J. L. McCLOUD, CHARLES HUDSON, W. A. TAUSSIG, J. J. MIKITA, and H. L. HEMMINGWAY....."Steering Geometry Characteristics and Their Influence on Car Handling," by H. E. CHURCHILL and P. G. HYKES, Studebaker Corp.; "A Modern Approach to Ignition," by CHESTER CIPRIANI and L. H. MIDDLETON, Electric Auto-Lite Co.; "Character in Styling of Automobiles," by WILDER HOBSON, Fortune; "Revolutionary Developments in Wheeled Military Vehicles," by COL. J. M. COLBY, Army Ordnance; "An Automotive Designer's Concept of Steel versus Light Metals," by D. F. TOOT, Chrysler Corp.; "The Automotive Industry's Participation in Reduction of Radio and Television Interference," by P. J. KENT, Chrysler Corp.; "The Highway Traveler," by M. M. DEAN, Greyhound Corp.; "Factors Affecting the Design and Installation of Wiring Systems for Commercial Vehicles," by L. C. WOLCOTT, Packard-Electric Division, GMC; "Anti-detonant Injection," by C. H. VAN HARTESVELDT, Thompson Vita-Meter Corp; "Use of Anti-Detonant Injection in a High Compression Ratio Engine," by R. I. POTTER, Standard Oil Co. of Ohio; "Progress Report on the Dual Fuel System," by W. M. HOLADAY, Socony-Vacuum Oil Co.; and "Taking the Guesswork Out of Crankcase Ventilation," by B. G. BROWN, Ford Motor Co.

All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

(Left to right) Wallace Hallam, Pittsburgh Section Chairman for 1947-48; Past-Presidents B. B. Bachman, A. J. Scaife, Arthur Nutt, A. W. Herrington, W. S. James, James M. Crawford and SAE Secretary and General Manager John A. C. Warner.

Laying aside for a moment cost-to-make and cost-to-operate considerations (which are looking up), pending improvements announced at the meeting point to big steps forward. Noteworthy reception was given to fuel-saving and petroleum-reserve-conserving ideas from researchers who suggested antidetonant injection and dual-fuel systems to boost gasolines antiknock quality without going to higher octane fuels.

Two engineers told of needling the engine with antidetonant solutions - such as 50% water and 50% alcohol, or 85% alcohol, 15% water and 3cc tetraethyl lead. This fools the engine into treating the gasoline as a higher octane product, it was said, stretching miles per gallon and keeping the engine cleaner. Two ways of taking advantage of this were suggested. First, high compression ratio engines could operate on present fuels. Second, conventional engines could get along with lower octane gasolines than they normally need... regular instead of premium, for example.

Instead of waiting for development and marketing of higher octane gasolines (which requires staggering refinery investment,) motor vehicle makers might bring out high compression ratio engines using present premium fuels plus antidetonant injection. The Vitameter device, which feeds the antidetonant solution to the carburetor, was described in detail.

A conventional car equipped with a Vitameter, powered by a 9 to 1 compression ratio engine, demonstrated at the meeting, ran on premium gasoline - 85 to 87 octane number - and evidenced no detonation with antidetonant injection. Yet, according to demonstrators, this engine normally wants a 100 octane number fuel.

In the light of an inviting reduction in gasoline consumption with high compression engines, several argued the public shouldn't be kept waiting until appropriate fuels are available. Antidetonant injection, they said, is one way to fuel these engines properly without marketing or engineering difficulties. And this method was said to be competitive costwise with increasing octane number in the refinery.

To one industry leader this represents a 30% extension of our petroleum reserve. . . . 15% savings from high compression engines and 15% conserved by anti-detonant injection.

Much promise also was claimed for anti-

detonant injection in existing cars and commercial vehicles. A truck fleet now running experimentally on straight-run gasoline (about 60 octane number and containing no lead) is spending about ½¢ per gallon of gasoline for antidetonant solution. From this accrues a 10 octane number boost, greater fuel economy, and, the operator believes, reduced maintenance.

Another engineer told of progress in seeking the same ends via another route - dual-fuel systems. He looks to a fuel system that feeds the engine low octane gasoline for high manifold vacuum. (Apparently the vehicle can get along even on heptane - zero octane gasoline - for normal driving.) For low manifold vacuum, as in accelerating or hill climbing, this system would feed the engine a stauncher diet of high octane gasoline.

TWO-FUEL SYSTEMS

An experimental dual-fuel carburetor described makes the changeover from one fuel to the other without an interruption in performance. This petroleum engineer said it minimizes blending of the two fuels in the carburetor passages. Another arrangement tried consists of two electric pumps replacing the conventional fuel pump.

Two jobs were seen ahead before industry can consider the dual-fuel system for speeding up introduction of high compression engines. First, engineers must tie down the relationship between manifold vacuum and high octane fuel consumption under varying driving conditions. Second, they must determine effect of vacuum changeover point on permissible spread in octane number between the two fuels.

The fuel-saving motif continued in reports from ignition engineers who found this goal the second bird they were killing with one stone. It all started, they said, as an effort to prevent radiation from vehicle ignition systems from fouling up reception of television reception. With television marketing mushrooming and extensive coaxial transmission lines under construction, the motor vehicle industry was faced with the problem of stopping this nuisance.

Working on this problem since 1944, an SAE committee, together with the Radio Manufacturer's Association, found the cure lies in: (1) a more compact ignition system and (2) adding suppressors to the ignition coil and each spark plug.

First step already has been taken by car manufacturers, said the SAE group chairman. Suppression was delayed until more could be learned about its effect on vehicle performance.

But instead of impairing performance (as originally suspected,) suppressors proved a blessing in disguise by enhancing performance, according to two ignition engineers. Not only do they not interfere with normal ignition functioning, but they permit increased spark gap and help halve electrode erosion.

Test data revealed that resistor plugs set with a 0.035-in. gap and nonresistor plugs initially set with a 0.025-in. gap both eroded to 0.040-in. after 10,000 miles. And further tests show this wider gap setting drags about one additional mile from each gallon of gasoline in the lower speed range.

Another way of getting the same results without suppressors, advocated by some engineers, is the use of resistor cable. Well along in development, this cable has a conductive rubber core and a resistance of 7000 ohm per foot. Proponents of this approach feel a distributed resistance to be more effective than a lumped one.

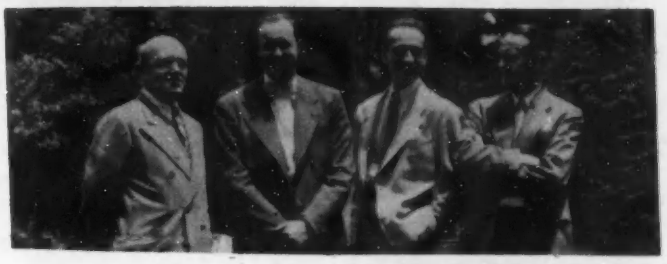
ECONOMICS PREDICTED

These suppression techniques open the door to several attractive possibilities, opined several engineers. They see smoother idle and better low-speed, light-load operation. Also ignition equipment makers can change coil characteristics to produce higher secondary voltage without increasing energy in the spark. And third, with these changes, leaner mixtures may be used to up gasoline economy under low-speed, road-load conditions.

Engines also will stay cleaner longer, observed another speaker, who told of improved crankcase ventilation techniques. He said it is now possible to pass a fairly constant amount of fresh air through the engine to remove sludge-promoting

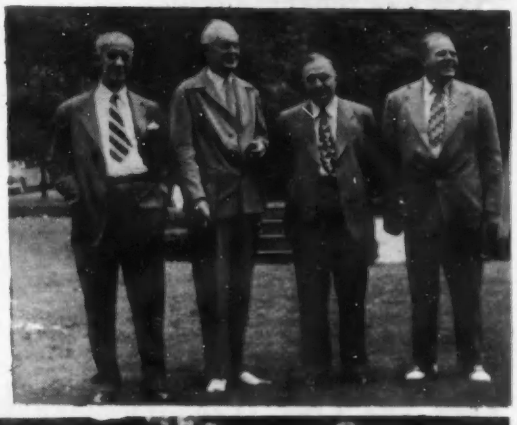
These diners are, clockwise, H. B. Dodge, L. L. Bower, A. J. Aukers, F. M. Young, and A. M. Wolf

Caught in conversation are, in the usual order, Joseph Geschelin, C. H. Van Hartesveldt, C. W. Georgi, and J. T. Bugbee



Going 'round the table from left to right, this luncheon group consists of M. J. Brennan, L. E. Wells, S. A. Jeffries, T. E. Nagar, and R. W. Johnson

E. H. Husted, Frank Jardine, R. R. Teetor, and S. G. Tilden are enjoying Indiana sunshine on the hotel grounds



Pied Pipers of the French Lick High School led a goodly crowd to the funful Field Day festivities, directed by Sam Dickey

blowby, regardless of operating conditions. Flaw in previous designs was that the engine got too little fresh air at idle and low speeds, while limiting outlet flow to prevent oil removal was the problem at high speeds.

At least two breathing improvers were said to be available. First, an impact breather and road draft tube provide a definite restriction in the outlet which limits high-speed flow without sacrificing low-speed gains.

Second, switching from outlet to inlet control achieves independence from load and speed, eliminates susceptibility to plugging from outlet gases. Inlet flow control, it was pointed out, more nearly provides a constant amount of fresh air since blowby will have less effect. A specially-designed motor blower, now said to be available, provides a means for positive inlet control.

Engineers examined with caution the prospects of weight saving with aluminum. One materials engineer advised designers to face realities of aluminum's handicaps before swinging over from cast iron and steel. Properties such as yield strength, endurance limit, modulus of elasticity, and hardness, he said, currently are retarding the move toward the light metal.

For example, a heat-treated wrought aluminum part need be only 10 to 15% thicker in gage than a steel part to give comparable yield strength. But aluminum is penalized in parts of severe draw or with sharp bends because dead soft material must be used. Portions getting little cold working retain a low yield strength and must be twice as thick as steel to give the same strength.

Some experimental aluminum fenders described, though 40% thicker than their steel counterparts, were seriously dented in the slightly cold-worked crown by stones hitting the underside.

Where stiffness counts, aluminum also takes a licking; its modulus of elasticity is only one-third that of steel. And unheat-treated aluminum is also one third as hard as mild steel. For this reason designers said they were not inclined to use it for wearing parts and feared scratching would destroy its looks when in exterior parts. Chromium plating of aluminum to resist wear, some felt, might be affected by the soft underlying material.

From behavior of parts and materials, engineers turned to behavior of the vehicle as a whole in steering. Review of steering geometry principles by two suspension specialists crystallized the relationships of factors such as cater, camber, tread, toe-in, and turning angle for easier steering effort. They also advised that steering characteristics depend on proper rear wheel geometry as well as going's on in the car's front end.

PRICE OBSTACLE SERIOUS

Focusing on costs of all these coming car improvements left several big question marks looming as to when they'll be adopted.

Economic realities put a slight damper on enthusiasm over antidetonant injection and dual-fuel systems. Will the vehicle owner be willing to bear higher initial car cost in return for promised lower operating costs, many asked.

The public and fleet owners will have to be educated on the benefits of these fuel stretchers before they will pay the price, some argued.

Adding ignition suppressors to cars, whether built-in or external types, also raises the car cost - just when manufacturers are fighting rising costs.

The resistor cable proponents feel that it will cost little, if any, more than present cable, and will last the life of the vehicle. Resistor plugs, they say, will have to be replaced by the car owner, as any other plug, at an increased cost of 15¢ to 20¢ each.

But assuming new cars have suppressors or resistor cable, what about the more than 30 million vehicles on the road today, many at the meeting asked. How do you induce the present car owner, especially one who has no television set, to buy something for his car that returns no actually direct benefit?

Bright spots were seen in the aluminum cost picture along with full recognition of this material's limitations and advantages. Some parts are more economical in aluminum even at present aluminum prices, designers advised, than made of ferrous materials. Two reasons for this were given.

First, cast-iron parts, which carry practically no load at all, generally

William K. Creson (left), Summer Meeting golf chairman

Frank E. Farrell (right), winner of the SAE Golf Championship at the 1948 SAE Summer Meeting. This was his third successive victory of the annual event

R. G. Wingerter (far right), runner-up in SAE Golf Championship

are lots heavier than their function requires. Thin-walled die castings could weigh one-fifth the iron parts they replace. Processing the basic metal in the foundry also is less costly with die casting or semi-automatic permanent mold casting than with sand casting, production men at the meeting agreed. Second big cost advantage with aluminum parts is that die casting eliminates practically all the machining cast-iron parts require.

If discussions at the meeting are any index, designers will not leap to aluminum prematurely. Engineers are proceeding with caution, learning more about aluminum alloys, how to make them less hard to work with, and how to get from them their potential advantages without sacrificing any performance they get from steel.

AMERICAN-FOREIGN CAR STYLING ARGUED

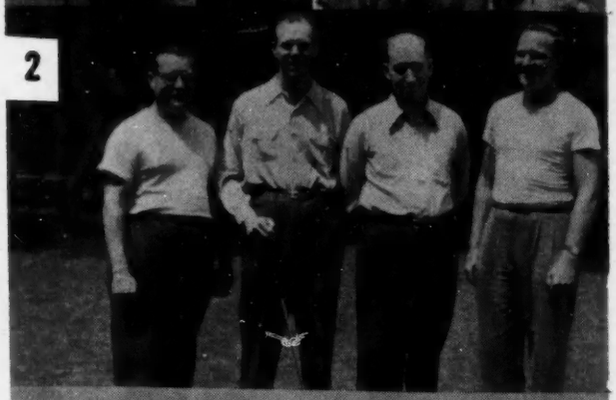
A nontechnical styling enthusiast who asked for "honesty" and "grace" as fundamentals of automobile body design got agreement to his general thesis - and strong opposition to his corollary that certain European cars embody these qualities to a high degree while American cars do not.

Several Italian bodies, which he called typical of the fluid, subtle school - and an English Bently, which he said had straightness without blubber - were brushed aside by most of the engineers present as failing to meet necessary American standards of comfort, protection from weather, and low-cost production. As opposed to the sports models upon which the honesty-grace thesis was primarily based, engineers pointed out that the average American car must take cost and production tooling much more seriously than do such custom-built jobs. Character is hard to achieve in a big car, several emphasized, than in a very small one.

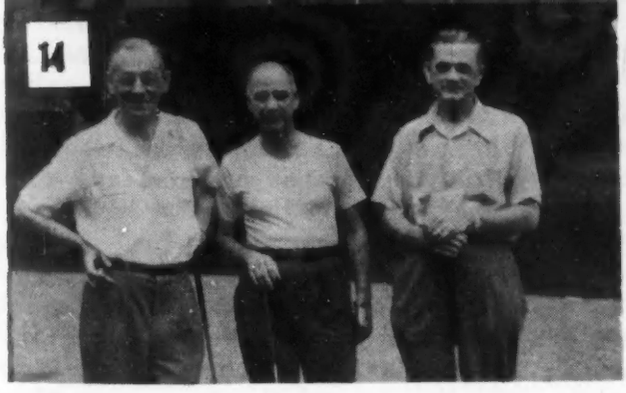
LESS UPKEEP; MORE PAYLOAD SEEN FOR TRUCKS

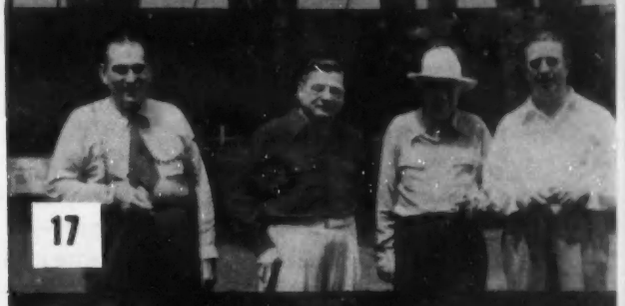
Truck and bus engineers at the meeting told the fleet man what new design steps they're taking to help cut his maintenance expenses and boost his payload revenue.

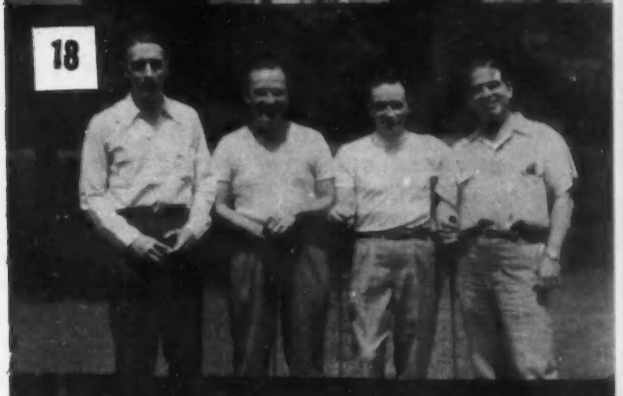
On the lowered maintenance side, commercial vehicle builders were seen concentrating on longer-lasting, less-troublesome wiring. They're also bringing out better crankcase ventilation systems



1. Dave Sicklesteel, George Allen, A. E. Kimberley and Oliver K. Kelley
2. T. F. Schrag, E. F. Riopelle, Herbert Snow, and Jack R. Splitstone
3. Russ Johnson, R. S. Johnson, R. W. Johnson, and E. W. Griffith
4. F. K. Glynn, George A. Round, P. A. (Micky) Kerns, George Humber and E. F. Donham
5. T. W. Flood, L. A. Wine, W. W. Pennington and P. J. Kent
6. B. F. Jones, W. P. Michell, D. D. Robertson and U. B. Grannis
7. R. V. Hessler, R. W. Roush and W. J. Allard
8. J. H. Clark, W. L. Bartholomew and E. B. Anderson
9. Van C. Worden, SAE Past-President W. B. Stout and A. B. Marshall
10. Earl Anderson, SAE Past-President J. H. Hunt and Jack Fleischer







11. C. O. Tongberg, W. K. Randall, T. C. Jones and J. M. Evans
12. Clayton Farris, P. E. (Jerry) Tobin and J. L. Carson
13. M. M. Ducody, M. A. Thorne and D. B. McCormick
14. SAE Past-Presidents, B. B. Bachman, J. M. Crawford and L. Ray Buckendale
15. W. J. Backoff, W. G. Clark, M. D. Gjerde and H. L. Moir
16. E. P. Lamb, M. P. Jolley, V. C. Young and M. L. Brown
17. C. D. McCall, Ferd Marschner, Fred Hall and Cliff Merrill
18. C. R. Scott, E. S. Robson, J. N. Waddell and L. J. Grunder
19. K. C. Gano, J. E. Hurn, W. A. Parrish and J. T. Greenlee
20. Gavin W. Laurie, R. C. Long, W. E. Niness and E. P. Gohn

to give the operator engines less susceptible to sludging. And some phases of military vehicle engineering stirred up interest on the maintenance side too.

Recent surveys revealing electrical breakdowns as one of the operator's costliest headaches emphasized a report covering electrical wiring practices of several vehicle makers and operators. These and other companies, an electrical engineer advised, follow this simple three-point formula for satisfactory wiring:

1. Adequate-size conductors for the current load they carry.
2. Conductor insulation strong enough mechanically and electrically to withstand environment and installation abuses.
3. Securely applied terminals and connectors.

Engineers were told the first of the three wiring objectives can be met with starting circuit cables adhering to this rule: Use a cable of such size that total calculated resistance doesn't exceed 0.001 ohm for 6 and 12-v systems, and 0.002 ohm for 24 and 32-v systems.

Type of insulation selected, it was pointed out, is a matter of weighing protection desired against cost. For example, neoprene-sheathed ignition wire resists oil, moisture, and excludes air. But it hasn't the dielectric strength and corona resistance of wiring with high-tensile glass yarn between the rubber and neoprene. Yet because of its more expensive construction, one engineer recommended it only for most severe truck and bus service.

Operators at the meeting welcomed promise of these longer-lasting wiring materials. But, they asked, where are they? Many cited instances of recently-purchased vehicles catching fire or breaking down on the road because of faulty wiring. One fleet man said vehicle manufacturers consider electrical wiring as an afterthought. Get it into the pre-drafting board thinking, he urged.

If better, longer-lasting, moisture and wear-resistant materials are available, give them to us, operators unanimously requested. We'll gladly pay more for it, they said, because it'll save us much in both idle time due to electrical failures and in need for premature rewiring. They deemed the price for better wiring materials and layout a worthy investment for $10,000 to $15,000 vehicles.

Urgency of the better wiring demand is implicit in reports that insurance companies are loathe to insure present-day trucks, even new ones, no matter what the premium. One fleet man said he had to buy his insurance from a British firm.

A tip given on terminals - whether soldered or crimped connections - was that the terminal should grip the insulation as well as make contact with the conductor of smaller size wires. Gripping only the exposed conductor invites trouble because the conductor will tend to bend sharply and break just back of the terminal. Retaining the insulation within the terminal, it was said, distributes flexing stresses for a greater distance back of the terminal.

Interesting ideas for the economical-maintenance-minded operator emerged from details of an Army Ordnance program to provide a complete range of Army engines - from 100 to 1040 hp - using only two basic cylinders. According to an Ordnance officer, all high mortality parts are to be interchangeable. Though probably commercially unsound, such plan would be a blessing in big-fleet parts stocking and maintenance, some conjectured.

A possibly more practical, though still distant, promise was carried over from the new military vehicle developments into the greater payload and revenue discussions. Greyhound's advanced new bus design and aluminum-for-steel replacements in new Army vehicles also stimulated thinking on income-expanding possibilities.

The Army was reported enjoying handsome weight savings with a vertical crankshaft, 250-hp aircooled engine powering a 6 x 6 cargo carrier. This power package tips the scales at 1600 lb under its water-cooled counterpart. And it takes only little more than the space for radiator and fan of a comparable liquid-cooled job.

Engine specialists uttered little hope for aircooled powerplants in commercial vehicles in the near future, citing the siren-sounding fans they require and high heat discharge as but a few of the real problems. But translating this economy into increased payload left fleet men wide-eyed with provocative new notions on weight saving.

Operators saw how designs like the Greyhound Traveler could add profit by attracting new patronage to luxurious motor coach travel and by raising vehicle passenger capacity. They saw a snack bar, toilet, better vision windows, and individual radio units for each passenger in this bus. If they went for a ride, they sat in wider, more comfortable reclining seats and enjoyed refreshing air from the air conditioning system.

In addition to admiring these features, many felt this bus was well engineered. They based their contentions on the fact this double-decker, 50-passenger coach was built by Greyhound within legal size and weight limitations of 37 and 41-passenger buses, except that it's 14 in. higher. This greater passenger capacity could mean eliminating half-empty bus runs where needed to accommodate overflow from regularly-scheduled coaches.

FUELS, METALS Advances Require Changes In Design, Specifications

ADVANCES in petroleum technology and in metallurgy are bringing about a need for reconsideration of specifications for diesel fuel, gasoline, heat treatment of parts, and cast iron, Fuels and Lubricants and Materials sessions showed. Speakers and discussers pointed out a number of places where designs can be revised in the light of new information so that specifications can be relaxed or new specifications written to save money for manufacturers and consumers.

Based on six papers and discussions, presented at one Diesel Engine, one Fuels and Lubricants, and two Materials sessions, under chairmanship of W. W. YOUNG, H. L. HEMMINGWAY, W. E. JOMINY, and J. L. McCLOUD...."Production and Performance of Diesel Fuels," by J. R. MacGREGOR, G. R. MacPHERSON, and P. L. PINOTTI, California Research Corp.; "New Approach to Evaluation of Fuel Volatility and Associated Engine Variables," by J. E. TAYLOR, Gulf Research & Development Corp., and H. J. GIBSON, Ethyl Corp.; "Principles and Applications of Isothermal Heat Treatment," by J. M. HODGE, Carnegie-Illinois Steel Corp.; "Section Size-Hardness-Composition Relationships in Cast Iron," by R. G. McELWEE, Vanadium Corp. of America; "Present Status of Surface Finish Control," by C. R. LEWIS, Chrysler Corp.; "Application of Nondestructive Testing to Automotive Parts," by D. M. McCUTCHEON, Ford Motor Co....All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

The catalytic cracking facilities being installed now in place of the older, cheaper thermal cracking plants put economic pressure on refiners to obtain maximum production of their high-priced product - gasoline - fuel men reported. Best feed for the crackers producing gasoline is straight run gas oil fractions in the diesel-fuel boiling range. Because so much in this range is being diverted to crackers, refiners must supply diesel customers partly with catalytically and thermally cracked gas oil, which is of lower ignition quality.

Either the customer must pay for extensive refining of this poorer quality oil, or he will need diesel engines which can burn it without extra processing, the oil men said.

They suggested that diesel engine builders look over their fuel specifications with an eye to ending any which are unnecessary and adopt any mechanical aides which will enable use of lower quality fuels.

Fuel men think it may be cheaper to cut down wear due to sulfur by such mechanical aids as improved liners and rings, higher operating temperatures, and more effective lubrication, rather than by removal of the sulfur from the fuel.

The builders of diesels for other-than-railroad use wanted to know what to expect in the lower quality fuels which re-

finers say they want customers to use. They were told to expect cracked stocks and maybe importations - the cracked stocks low in sulfur; the importations perhaps high in sulfur. Cetane numbers will tend to go down.

Catalytic cracking, along with polyforming, may affect design of gasoline engines, too, according to fuels men. These processes will produce high-octane hydrocarbons of low volatility. At the same time, refiners using older equipment may need to raise volatility to meet octane number requirements. The result will be more fuel at lower cost, but wider variation in its volatility.

TEST LINKS WARMUP TO VOLATILITY

Engine builders may want to modify their engines to accommodate the increased volatility spread, it was indicated. As a tool for developing these modifications, two fuel experts have worked out a new means of evaluating effect of volatility on warm-up performance. They run the car at 20 mph, road load, and measure its performance at the end of each minute of operation until it is fully warmed up. Measurement of car performance is based on speed attained at the end of 6 sec of full-throttle operation, starting at 20 mph. The method lends itself particularly to dynamometer testing in cold rooms.

Applied to a number of engines, this procedure indicates marked differences in warm-up ability of various cars and proves the value of manifold heat and cleanliness. Testers found that inoperative manifold heat is equivalent to a 40 F drop in the 50% evaporated temperature of the fuel and that a dirty manifold can equal a 30 F drop.

Discussers who had used the test praised it as providing more information faster on what happens during warm-up than older techniques and as a good yardstick for comparing manifold designs.

Now that metallurgists know how to control microstructure of steel precisely by isothermal heat treatment and can correlate microstructure with physical properties, they have evolved new heat treating processes which are better than conventional quenching and tempering for many applications.

Most widely used of the new isothermal heat treating processes is austempering, described by a heat treatment authority as a process in which the part is quenched rapidly to a temperature in the lower bainite range and held at this temperature until all the austenite is transformed into bainite. Chief advantage of austempering, he pointed out, is that transformation stresses incurred at this high temperature are low enough to avoid quench cracking and minimize distortion. He added that strength and ductility of lower-bainitic microstructures are comparable to those of tempered martensite, which is considered the optimum microstructure for these properties. In deciding whether to specify austempering or conventional quenching and tempering, designers were warned to weigh the advantages offered by austempering - fewer cracks and less distortion plus equal strength and ductility - against the higher cost of a steel of greater hardenability. (The greater hardenability is needed to prevent transformation of the austenite to undesirable structures during the initial cooling.) Comparison will often favor austempering for sheet, wire, automobile bumpers, and other parts of small section, it was said.

A wealth of foundry experience has shown that when there are difficulties with casting performance of gray cast iron, it is often better to select an iron having higher carbon content than to raise tensile strength specifications, a foundryman revealed. Higher carbon content shortens the freezing period, during which shrinking continues but feeding is difficult. The shorter the freezing period, the less the shrinkage and microporosity - a distinct economic advantage.

Three reasons for current troubles with gray iron were emphasized: 1. The coke is of poorer quality. 2. Little pig iron is available. 3. The scrap iron used to make up charge is low in carbon.

To offset these conditions, engineers were urged to help their foundrymen by segregating casting work according to section size and by accepting low silicon content.

After reviewing the present status of surface finish control, a member of the

Thompson Vita-Meter Corp., Standard Oil Co. of Ohio, and Quaker State Oil Refining Corp. engineers demonstrated antidetonant injection at the meeting in these cars

New Developments Previewed

Weight-saving aluminum body structure, torion bar suspension, and aircooled engine are features in this first-of-its-kind 6x6 military vehicle, built by GMC, and displayed by courtesy of Army Ordnance

Army Ordnance also demonstrated this new Chrysler-built 4x4 cross country carrier

Greyhound's experimental 50-passenger bus was ride-tested by most at the meeting. Air conditioning and a combined air-spring and torsilastic spring suspension are but a few of the passenger comfort items engineered into this coach

SAE Surface Finish Project Committee said that present knowledge is far too inadequate to permit specifying the finish to be used on a specific part. He urged that SAE continue its interest in establishing criteria of surface quality - including both roughness and character - and in promulgating standards to serve as reference points in surface finish studies.

Another speaker, a member of the SAE Iron and Steel Technical Committee's Division XXV on nondestructive test standards, outlined a number of the modern nondestructive techniques. He explained that the committee hopes to formulate recommended practices where practical and to set forth essential information on various tests, especially their limitations.

Car, Bus Developments Highlight Sessions on NEW VEHICLES

HOW-it-was-done shared equal billing with what-was-done in descriptions of three new car engines, the new Hudson, and an experimental Greyhound bus. Commercial vehicle designers at the meeting also gleaned several ideas from discussions of advanced military vehicles.

Based on five papers and discussions, presented at one Passenger Car, one Body, and one Transportation & Maintenance session, under chairmanship of D. G. ROOS, K. E. COPPOCK, and CHARLES HUDSON.... "The New Packard Straight Eight Engines," by G. A. SPRAGUE, Packard Motor Car Co.; "The Willys-Overland 148 Cubic-inch Six-Cylinder Engine, by PAUL HUBER, Willys-Overland Motors, Inc.; "Features of the Nash Engine," by E. L. MONSON, Nash-Kelvinator Corp.; "Hudson's New Look," by F. S. SPRING, Hudson Motor Car Co.; and "The Highway Traveler - Greyhound's New Intercity Bus," by M. M. DEAN, Greyhound Corp....All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

The new engines—Packard's line of straight eights, Willys-Overland's six, and the Nash "600" - each boast unusual features of their own.

Two new Packard engines (the 327-cu in. super eight and the 228-cu in. Packard eight) are interchangeable in every respect, except for crankshaft, connecting rods, intake manifold, and cylinder heat. Dampers also differ, said a Packard man. He pointed out that these and a third engine are assembled on the same line. At first, wrong connecting rods or heads were sometimes assembled to the engine; but markings now prevent such mistakes.

This design plan fully exploits tooling and realizes production economy, parts interchangeability, service simplicity, and faster final delivery, this engineer advised.

The Nash engine, according to one of its designers, is noteworthy for its sealed-in type of intake manifold. It is cast within the cylinder block, practically surrounded by water for temperature control.

Nash feels that conventional manifolding maintains fuel mixture temperatures over too wide a range. Low car speeds in cold weather, it is claimed, produce low mixture temperature in the end ports, inducing mixture condensation and upsetting distribution. And high-speed driving with full-throttle operation brings about high temperatures. But the sealed-in manifold creates constant manifold wall temperature conditions. Nash says it generally permits leaner part-throttle mixtures and boosts output at full-throttle operation.

Third new engine, the Willys-Overland 6-cyl design, is built in a compact package. About 10% larger than the famous 4-cyl Jeep engine, this job packs a little more power, is smoother, and more flexible for passenger car operation, according to the company's research director. It displaces 148.4 cu in., has a 3-in. bore and 3 1/2-in. stroke. The

bare engine weighs 411 lb.

Hudson's postwar car, said the company's styling director, embodies these five design features: It is (1) lower, (2) easy to get in and out of, (3) has better vision, (4) handles better, and (5) gives better high-speed economy. It's a radical departure from the company's previous models.

Though built for totally different service, Greyhound's new bus and the postwar military vehicles exhibited at the meeting boasted similar engineering achievements - aircooled engines and good ride comfort because of unusual suspensions.

This double-decker intercity bus is powered by a unique twin, aircooled engine installation. The engineer who designed the bus said one engine normally propels the coach; the other drives the accessories. Both are rated at 154 hp. The auxiliary engine cuts when extra power is needed for maintaining or increasing speed.

Greyhound engineers attained good ride (as demonstrations at the meeting revealed) by springing the body on two air-spring cylinders together with torsilastic springs. Chief engineer of the coach design said that placing spring suspension points relatively high (near the center of gravity) keeps side sway to a minimum.

Other traveling luxuries in this bus include year-'round air conditioning, individual radios, snack bar, refrigerator, "sight-seeing" windows, toilet (and almost everything but the kitchen sink).

Commercial vehicle engineers and operators were fed food for thought by an Army Ordnance officer with his announcement of several experimental military vehicles. Most attention focused on a new aircooled engine and torsion bar suspension.

He said the 250-hp vertical opposed, aircooled engine powering a new five-ton 6 x 6 Cross Country Carrier saves cargo space and weighs 1600 lb less than a comparable watercooled engine. Yet this design occupies little more space than a radiator and fan for an equivalent watercooled engine.

Torsion bar springing on the new 6 x 6, for ironing out rough terrain to permit faster speeds, was said to offer improved cushioning from shock for saddle-sore civilians as well as for military personnel. This suspension, with primary and secondary torsion bars, the Army feels, does the job within space limitations and promises great reliability. (World War II vehicles, it was said, shook to pieces rather than wore out.)

Continued industry support on work such as this was urged for maintaining military vehicle superiority in the event of another conflict.

EXPLAINING HOW

Engineering ingenuity, translating original conceptions into these new products, combined just good technical horse sense, together with novel, untried ideas. Courageous engineering, as exemplified in these cases, was termed the propelling force that keeps the industry marching forward.

Production of the new Packard engine line was credited in large part to judicious use of research and development tools. Stresscoat uncovered certain structural weaknesses; shot peening prevented cam tappet-face scoring; piston-ring scuffing disappeared with revised ring design.

The Packard engineer told how one of the three new engine types operated roughly and rattled at 1400 to 1600 rpm under moderate load in initial dynamometer tests. Sound-measuring equipment showed up vibration in the lower wall of the cylinder-block crankcase section. Coating the crankcase section with Stresscoat lacquer disclosed strain in two areas. It led to stiffener redistribution that effectively eliminated vibration and noise.

The large intake valves and high lift cam plagued Packard's early development program with incipient tappet-face scoring, this speaker continued. An attempt at improving lubrication failed to produce improvement. But shot peening, it was reported, eliminated the scoring.

In another instance Packard dynamometer and road testing uncovered piston-ring spinning with resultant wear near 70 mph. Apparently the compression rings were

vibrating in resonance with the frequency of another disturbance, the engineers surmised. Damping this resonant vibration by changing the ring section solved the problem.

The Nash engineer told how his colleagues short-cut development work of the type usually required for sealed-in intake manifold. They used plaster of paris and iron cement or solder to find the best design. In a matter of minutes they could increase or decrease port radius, fill in or grind out the bottom to change capacity, and try many possibilities to get proper distribution. Normally it takes days to change a conventional manifold pattern, getting a casting, and then machining it before the next test run can be made.

Uncommon features of the Willys-Overland six were said to stem from its compactness. For example, cylinder bores are siamesed in three pairs. Full-length water jacket, though essentially conventional, narrows down in some spots. Third important variation pointed out is positive crankcase ventilation as standard equipment.

After passing through the air cleaner, air is fed into the engine through a tube connected from the valve cover to an automatically-controlled valve mounted just below the carburetor. This positive ventilation system, the Willys engineer claimed, minimizes deposits and keeps the engine relatively clean.

Hudson's aims of a lower car, that's easier to get in and out of and which has better vision, added up to pretty much the same problem, it was reported. At first, entrance height was decreased when making the car lower. Getting in and out wasn't easy, the designers found. But widening the frame-to-body width and lowering the floor - to permit stepping down into the car - achieved the old entrance height.

Fourth objective - better handling - was met by lowering the center of gravity and moving it forward. This, incidentally, retains the suspension layout of the old car. Some engineers questioned the car's ability to make high-speed turns with the relocated center of gravity.

Shooting for better high-speed economy produced the car's present styling form, advised Hudson's styling chief. Drag has been reduced 40 to 50%. Economy and acceleration at 80 mph roughly equals that at 65 mph in the 1947 model. Top speed also is improved. The new Hudson will cruise quietly and easily at 95 mph, the company claims, with no sensation of unpleasantness. And wind noise at 80 mph in the new car is less than at 60 mph in the old one.

Bigger, More Powerful Units Considered for AIR, RAIL, ROAD

TAKING a look into future air, rail, and highway transportation, speakers speculated on extension of present limits of size, speed and power for aircraft and for diesel-electric locomotives and on upping of legal gross weight limits of motor vehicles. An observer of the air transport industry said while

Based on five papers and discussions, presented at one Air Transport, one Aircraft Powerplant, one Diesel Engine, and one Truck and Bus session, under chairmanship of R. D. KELLY, J. F. HAINES, W. W. YOUNG, and B. B. BACHMAN...."Air Transport Problems," by Vice-Admiral E. S. Land (Ret.), Air Transport Association of America; "Potential Performance of the Turbojet Engine at Subsonic and Supersonic Speeds," by R. B. HENSLEY, N. D. SANDERS, and R. P. KREBS, NACA; "Cycle Analysis of Gas Turbine Propeller Engines with Turbine Blade Cooling," by R. O. BULLOCK and R. E. ENGLISH, NACA; "Super Power for Super Railroads," by J. W. BARRIGER, Chicago, Indianapolis, and Louisville Railway Co.; and "Future Commercial Highway Transportation," by J. S. WORLEY, University of Michigan.... All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

there may be few technical limits to the size of aircraft, there is a point of diminishing returns. He pointed out that when the railroads want more capacity, they don't build larger cars - they build more of them. Maybe there's a lesson in that for the airlines, he said.

Since 300-mph-plus planes already make it possible to breakfast in New York and lunch in Los Angeles, isn't that enough?, he asked. He doesn't expect to see commercial speeds exceed 350-450 mph for some time. But he suggested that commercial passengers could be given faster service without increased airplane speed if, under instrument conditions, military planes were required to land at separate airports. This would cut down stacking at congested airports. He added that it may take 10 or 12 years and over a billion dollars to equip the civilian airport system with ILS plus GCA.

However, NACA researchers turned their slide-rules loose on calculations at speeds up to 1500 mph in investigating the effects of compressor pressure ratio and turbine inlet temperature on gas turbine powerplant cycles. Their cycle analyses probed ranges beyond presently obtainable pressure ratios and component efficiencies and beyond metallurgically imposed temperature restrictions.

With turbojets for high subsonic speeds, high pressure ratio is especially desirable from the standpoint of good fuel economy and best range, they found. At 500 mph and 30,000 ft altitude, the near-optimum pressure ratio of 20 at 2000 R gives a range of almost 7000 miles.

High turbine-inlet temperatures are important not only because they develop high power per pound of air but also because they permit use of high pressure ratios with attendant high heat of compression. Cycle analysis of turboprops showed that high gas temperature is so beneficial to power, specific fuel consumption, and range that it is worth sustaining the losses incurred in cooling the blades - assuming that some means of liquid cooling hollow blades can be worked out.

Improvements in diesel-electric locomotives will be pushed soon to the point where more than 2000 hp can be placed in one cab of a road locomotive, according to a railroad man. Two large motors will turn each pair of driving wheels, he predicted. The motors' increased individual and total power will be transmitted through the quill form of spring-cushioned drive to the spokes of large-diameter driving wheels carried in the main frame of the locomotive, as is done now with all-electric locomotives.

DIESELS TRIUMPH OVER STEAM

More reasons for the rout of steam were disclosed in a review of the 50 years of diesel progress in this country: Although a diesel-electric locomotive requires a greater initial investment, each one replaces three steamers. The diesel offers marked savings per ton-mile. The savings in destructive wear of the rails alone are considerable. And the fact that several more manufacturers have entered the diesel electric competition in the last year will spur development.

The public will get more service from its highways in the future if limitations on weights and sizes of commercial vehicles are raised, a roads expert claimed. He backed up his plea for higher gross vehicle weights with the reasoning that maximum axle load - and not gross load - is the controlling factor for permissible loads on pavements.

Gross loads, he said, are critical only on bridges of 30 to 100 ft. No matter how heavy the motor vehicle, with the present spacing of axles, the number of axle loads on a 30-ft-or-less span at any one time will not overtax the span that carries ordinary traffic.

As one discusser saw it, the way to liberalize legal GVW limits and other restrictive legislation is to educate the citizen - particularly the man who fears to pass big trucks - on how liberalization would allow him to get more out of his investment in highways.

Truck manufacturers who talked of the advantages of stretching vehicle width from 96 to 102 in. assured worried passenger car drivers that the wider dimension is being proposed only for 10-ft-wide lanes and should be considered as a guide for design of future highways, rather than an around-the-corner development.

About

ALBERT B. WILLI, JR., has been appointed assistant chief engineer in charge of sales engineering at the Federal-Mogul Corp. of Detroit. He has been associated with the Engineering Department of Federal-Mogul since 1937.

WILLIAM H. TAYLOR was recently appointed director of engineering for Tinnerman Products, Inc., Cleveland. He joined this organization in 1945. He had previously served with Budd Mfg. Co., Packard Motor Car Co., Douglas Aircraft and the Ford Motor Co. In his new capacity, he will direct all Tinnerman engineering at the company's Cleveland plant.

BAYARD D. KUNKLE has been elected a member of the Board of Directors of General Motors Corp. and became a member of the corporation's Operations Policy Committee. He is vice-president and group executive in charge of Overseas and Canadian operations. Kunkle joined General Motors in 1925, starting with what is now the Delco-Remy Division.

ALFRED N. LAWRENCE, who has been in aircraft sales engineering and managerial capacities for 19 years, has been appointed division sales manager of Jack & Heintz Precision Industries, Inc., Cleveland. He has been with this company since 1944, and had also been connected with United Aircraft Products, Inc., Dayton, Ohio and Sperry Products, Inc., Hoboken, N. J.

ELMER A. SPERRY, JR., vice-president of Sperry Products, Inc., Hoboken, N. J., announced that the plant and executive offices will be moved to Danbury, Conn., late in August.

Heretofore a development engineer with the Baldwin Locomotive Works in Philadelphia, GEORGE T. HAMMERSHAIMB is now consulting engineer, in business for himself, at 44 Green Valley Road, Wallingford, Pa. He has been chairman of the SAE Philadelphia Section.

TED C. NING recently became resident representative for Consolidated Vultee Aircraft Corp., San Diego, Calif.

E. A. VOLK, JR., is now project engineer with Eclipse-Pioneer Division of Bendix Aviation Corp., Teterboro, N. J.

No longer a tool technician for the Glenn L. Martin Co., Baltimore, Md., KEITH E. COXE has become design engineer with S. Morgan Smith Co. in York, Pa.

J. L. McCLOUD has been appointed director of Chemical Engineering and Chemical and Metallurgical Research by Ford Motor Co., and not executive engineer as reported in the May issue. Two years after graduating from the University of Michigan, he became a chemist with the company, and later was made chief chemist for Henry Ford & Son Tractor Co. He was appointed assistant director of Chemical Engineering and Chemical and Metallurgical Research in 1946.

Prior to becoming a technician with the Canadian Government, Bureau of Mines, Ottawa, Ont., Can., MISS VIVIAN R. GOFF was a mathematical computer for the Stratos Corp. in Farmingdale, L. I., N. Y.

WILLIAM F. MAGUIRE, who had been truck manager of L Motors, New York City, recently became sales manager for the Ward LaFrance Truck Corp., same city. He was secretary of the SAE Baltimore Section in 1940.

LYLE E. CALKINS, chief chemist and materials staff engineer of Willys-Overland Motors, was elected chairman of the Toledo Section of the American Chemical Society.

JAMES R. BRIGHT, of Product Engineering, was promoted from associate editor to managing editor of the McGraw-Hill magazine, GEORGE F. NORDENHOLT, editor, announced.

DAVID R. OSBORNE, JR. is now project engineer for the Indian Motocycle Co., Springfield, Mass.

SAE Members

In his just-off-the-press second edition of "Thermodynamics," PROF. LESTER C. LICHTY, Yale University, has aimed at simplicity of presentation and modernization of the subject. Among the new additions are tables, replacing calculations of PV^k = constant for solving adiabatic-isentropic processes. They make for quick and accurate answer-getting. Discussion of each process is clarified by starting the analysis with the energy equation for the process rather than with some already-established relation. New additions to the book - published by McGraw-Hill - include material dealing with supersonic flow, Mach number, shock, jet and rocket propulsion, and ram-chamber and diffuser processes.

CHARLES H. COLVIN was recently elected a member of the Board of Directors of G.M. Giannini & Co., Inc., Pasadena, Calif., and will direct policies of the company's instrument engineering and manufacturing activities.

ARMAN E. BECKER, chairman of the editorial section, Division on Combustion Characteristics, ASTM Committee D-2, announces the publication of the ASTM Manual of Engine Test Methods for Rating Fuels. The 320-p. manual has 109 illustrations, and covers concisely the five engine test methods commonly used throughout the petroleum and automotive industries. Six supplements cover design of laboratory facilities, materials, and operation and maintenance of equipment. Including Dr. Becker, a past vice-president of SAE, eight members of the editorial committee are SAE members. They are LEO A. McREYNOLDS, HUDSON W. KELLOGG, CARL E. HABERMANN, EDWARD J. McLAUGHLIN, ROYCE CHILDS, BRUNO R. SIEGEL, and PRESCOTT C. RITCHIE.

T. CURRY JONES has joined the New York staff of Enjay Co., Inc., in lubricant and fuel additives (Paramins) sales, to assist A. B. BOEHM, sales manager.

SAE Members Said....

"We need the help of churchmen to readjust ourselves to the growth of science and knowledge. . . JAMES D. MOONEY, president and board chairman of Willys-Overland Motors, declared at Case Institute of Technology, Cleveland, May 20.

"We must win the peace if our nation is to continue strong and prosperous . . . This task requires just as much unity of purpose, energy, and talent as was required to win the war. . . If the 40-hr week was sound prewar, and the 48-hr week during the war, a 44- or 45-hr week would seem to be resonable now. . ." C. E. WILSON, president, General Motors Corp. before the Cleveland Chamber of Commerce, April 20.

GEORGE M. SPROWLS spoke on "Safety in the Use and Maintenance of Tires" at the Hollywood, Calif. meeting of the Western Governors' Safety Council on June 17. Sprowls is manager of the Highway Transportation Department of the Goodyear Tire & Rubber Co., Akron, Ohio. He joined Goodyear in tire design work in 1912.

DR. RAY P. DINSMORE, vice-president in charge of research for the Goodyear Tire & Rubber Co. Akron, Ohio, sailed on June 2 on the S. S. America for England where he received the Colwyn Gold Medal for 1947 presented by the Institution of the Rubber Industry. The award is being made to Dinsmore in recognition of his work in synthetic rubber research, development and application.

ABBOTT L. JOHNSON was elected president of Warner Machine Products, Inc., Muncie, Ind. He was formerly vice-president and general manager since 1933 and is also vice-president of Glascock Bros. Mfg. Co., same city. At the same time CHARLES S. DAVIS was elected chairman of the board and RAY P. JOHNSON was elected secretary and treasurer.

EDWARD J. GOUVIER is employed as time study observer, Industrial Engineering Division, for the Atlantic Refining Co., Philadelphia.

Heretofore a technical specialist with the Edo Aircraft Corp., College Point, N. Y., VICTOR WARSHAW is now layout design engineer for Chase Aircraft Co., Inc. in West Trenton, N. J.

Halliburton Oil Well Cementing Co., Bay City, Texas, recently employed LEO F. HERLACHER as district engineer trainee.

GEORGE A. CUNNINGHAM, formerly sales engineer for Imperial Oil, Ltd., St. Catherines, Ont., Can., has moved to Halifax, N.S., where he is this company's manager of industrial sales for Canada's Maritime Provinces.

LAWRENCE R. MILLER is now shop superintendent for Catlow Transport in Pasco, Wash.

MAYNARD B. TERRY has been appointed general sales manager of the American Brakelok Division of the American Brake Shoe Co. His headquarters will be in Detroit. Terry, formerly manager of equipment sales, has served in various sales capacities since joining the company in 1943.

Before becoming welding supervisor, Methods Division, General Electric Co., Somersworth, N. H., GERALD A. TOBEY was an instructor on industrial instrumentation with the Long Island Agricultural & Technical Institute in Farmingdale, L. I., N. Y.

JAMES MATTERN has been appointed production planning manager for the Sperry Gyroscope Co., Division of the Sperry Corp., at Great Neck, N. Y. He has been an SAE member since 1927.

CHARLES W. HAMMOND is a mechanical engineer with the H. K. Ferguson Co., New York City. Prior to this post, he was affiliated with Pacific Airmotive Corp., Atlantic Division in Linden, N.J.

Until recently connected with Columbia Records, Inc. Bridgeport, Conn., RAYMOND C. AMIOT has become a mechanical engineer with the Underwood Corp., same city.

GEORGE WILLIAM BORG is the subject of a new book by Robert J. Casey entitled "Mr. Clutch". The first president of Borg-Warner Corp. and now president of George W. Borg Corp., Delavan, Wis., Borg is characterized as "the boy who wanted to walk a tightwire and had to scale fish, the man who seldom gets into the newspapers, the 'prophetic Swede' who has never appreciated his own success." Borg has been an Associate Member of SAE since 1915. "Mr. Clutch" is published by Bobbs-Merrill Co., New York.

HARVEY G. MOORE, JR., has changed his business affiliation from the position of sales engineer with the Lord Mfg. Co. to that of assistant district manager of the Michigan area for the Wayne Pump Co., with offices in Detroit.

CONTINUED ON PAGE 88

MAURI ROSE was profusely congratulated by fellow employees at Studebaker Corp. for his winning, for the third time, the 500-mile Sweepstakes at Indianapolis on Memorial Day. He is a member of the company's engineering department. Trophy is for a previous victory

SAE Fathers and Sons . . . . .

JAMES B. FISHER, left, is vice-president and chief engineer of the Waukesha Motor Co. in Waukesha, Wis. and has been an SAE member since 1917. His son, CLARK A., is with Trans World Air Lines at the New Castle, Del. base, serving as an engineer in their power unit division. Throughout the war he was with the Air Corps in Alaska, and previous to his enlistment in 1941 was with the Sinclair Oil Co., Chicago, in their research department.

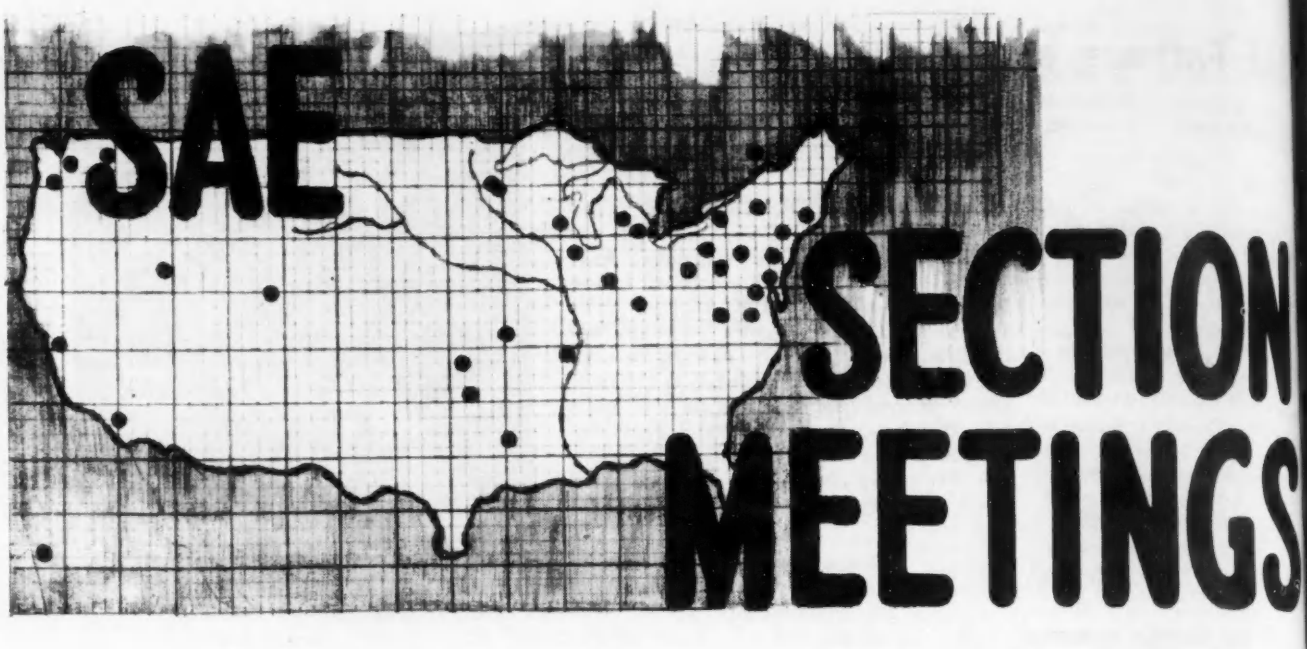
LUCIEN WARNER BINGHAM, left, with his two sons, WILLIAM H., center, and LUCIEN, JR. Father and both sons are partners in the Bingham Truck Service, Richmond, Va. He was the 1948 chairman of the Virginia Section.

If any SAE reader knows of SAE Father-and-Son combinations, both of whom are members of the Society, your editors would appreciate hearing from you.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated - we don't want to miss any SAE grouping.

HARRY E. McCRADY, assistant chief engineer for the Marmon-Herrington Co., Inc., Indianapolis, Ind. His son, HARRY, JR., is an engineer, transmission engineering group for the Allison Division of General Motors Corp., Indianapolis.



SIX INSPECTION trips marked Section meetings during May, Field Editor reports of 23 local sessions disclosed, and several Sections indulged themselves with outings.

SAE President Pigott visited CINCINNATI on May 18, INDIANA on May 20, and DAYTON the next day where SAE Past-President C.F. Kettering spoke on "A Review of SAE Engineering," and explained the important role of the Society's technical program in industry's progress.

Exhaust gas turbines geared to the engine promise to open the way to greater powerplant efficiency by converting some of the wasted energy into horsepower, Pigott told the INDIANA Section.

Nearly 300 members and students made a tour of inspection of the Waukesha Motor Co. as a feature of the MILWAUKEE Section's May 7 meeting, when J. B. Fisher, the company's vice-president; N. H. Willis of its Railway Division, and Royce Childs, fuels research engineer, gave papers.

C. B. Lonsdale, with Ford of Great Britain, believes there is a large market for the small, low hp British type of automobile in this country, but told the NEW ENGLAND Section on May 4 that the small car will never predominate in the American market. Many of the parts are interchangeable with domestic Fords. Charles M. Jordan, vice-chairman of the M.I.T. SAE Student Branch and winner of the GM Fisher Body Craftsman Guild Contest, described how he built the model which was shipped in by air express.

CANADIAN Section's membership stands at an all time high, retiring Chairman Ed. F. Armstrong told members and guests at the Oshawa dinner May 14. Speaker was Charles A. Chayne, Buick's chief engineer, who described the Dynaflow transmission to an overflow audience. Warren B. Hastings, incoming chairman was introduced - a formality for one of that group of veteran SAE members who have made the Canadian Section one of the most vigorous among local organizations of the Society. Col. R. S. McLaughlin, chairman of General Motors of Canada and "dean" of Canadian members, signed the Roster presented to the Section by Past-Chairman and former SAE Vice-President Alex S. McArthur, one of the founders of the Section. SAE Past-President W. J. Davidson was present.

Cross-wind landing wheels would permit aircraft of any size to operate from a single landing strip more than 95% of the time in the windiest part of the U.S., O. W. Loudenslager, Goodyear Tire & Rubber Co., told WICHITA members March 11. The speaker described the work done on wheels for small personal aircraft and the later successful installation of larger gear for a DC-3.

More than 80 PITTSBURGH Section members went 90 miles to Oil City where more than 150 gathered for an outing, dinner, and technical meeting which closed the season and the administration of Chairman N. H. Werner. Torque converter fluids and maintenance of the transmission were discussed by E. F. Collins, GMC Truck & Coach Division. Enthusiastic discussion continued until eleven o'clock when Technical Chairman H. H. Donaldson closed the meeting.

DETROIT Section's questionnaire to junior members disclosed the desire for a panel type of meeting on suspensions, and this they had May 10, at the second and successful junior meeting this season. The panel of four juniors was composed of Conrad Reuther, Chrysler; Bert Andren, Lincoln-Mercury; George E. Adams, Ford, and Fred Cowin, Cadillac. Senior discussers included Robert Schilling, GM Research; Phil H. Pretz, Lincoln-Mercury, Glenn Parker, Chrysler; and Philip Rothwell, Chrysler, was the moderator.

On May 17 DETROIT Section again turned out in force to hear Joseph Geschelin, Detroit editor of "Automotive Industries" discuss the steel shortages interpreted in terms of the automotive industry. He disclosed new evidence of ingenuity of automotive engineers in substitutions and alternates to relieve the steel shortages. Judicious use of low-alloy high-tensile steels was urged by a number of engineers who have had satisfactory results with this material. Earle C. Smith, Republic Steel's chief metallurgist, vigorously urged a

realistic appraisal of the short supplies of nickel manganese, chromium, and other ferrous alloys, and urged realistic appraisal of the future. Reynolds Metals showed an automobile with numerous trim and other parts made of aluminum.

NORTHERN CALIFORNIA enjoyed a tour of the Pan American Air base at Mills Field on March 24, where they saw a film and heard a paper on "Engine Fluoroscope - Trouble Shooter" by John E. Lindberg, and saw the equipment demonstrated on Sperry's DC-3.

The United States should have no immediate fear of Russia from

CONTINUED ON PAGE 84

SAE Section Chairmen

Shortage of space has delayed printing of these biographies of 1947-1948 Section Chairmen

COLLINS

. . . . of Syracuse

Starting with the Maxwell interests in 1916, John L. Collins soon changed work and entered aircraft engineering with Curtiss. When World War I rolled in from the east he joined the Navy.

Back in his home town of Lead, So. Dak., he was soon running a transit for the Homestake Mining Co., but automotive work won over civil engineering and in 1920 he joined the H. H. Franklin Co. in Syracuse.

About 24 years ago he became an engineer for New Process Gear Corp., where he rose to his present post of assistant general manager.

Active in SAE work since he joined the Society 20 years ago, he is a member of the Automotive Panel of the SAE Iron & Steel Committee.

He was elected the first chairman of the Syracuse Section of the Army Ordnance Association. In summer it is golf, for which he keeps trim during the winter by bowling - or vice versa.

- by William F. Burrows

INSLEY

. . . . of Detroit

Robert Insley belies his apparent calm by getting excited enough about a new idea to design things on hotel laundry bags. He comes by his ingenuity naturally through his grandfather, a broom manufacturer who pioneered in daguerreotype development. Bob's father found that he could study law and support his family, and did so, and became a lawyer.

But engineering struck the third generation with a brother a ceramic specialist (with his PhD) at the National Bureau of Standards, and another is an electrical engineer with the Bell Telephone Laboratories, New York.

Bob explains his $(BS)^2$ thus: His first bachelor's is from Hamilton, a classical college founded by the nation's first secretary of the treasury, and his BS in ME at M.I.T., because he felt Hamilton's physics a bit light. (Testing bulbs for commencement was the sole lab work, he recalls.)

A 14-month stretch in the Navy interrupted his work at Cambridge, after which he was test engineer at McCook Field and had a hand in developing facilities at Wright Field. The die was cast and he joined Continental in 1928 and fathered the A-40 and A-70 aircraft engines. Between 1933 and 1942, Detroit Section's chairman was with Pratt & Whitney in East Hartford and Menasco in California.

Returning to Continental he became vice-president in charge of engineering. Few men have been as active in SAE work as has Bob, who served as chairman of Dayton Section, twice vice-chairman of Detroit Section, and active in East Hartford and California.

His oldest son is studying electrical engineering, his second has his sights set for West Point, and at 15 the youngest aims at picking up a mere $100,000 in professional baseball, a neat stepping stone, he thinks, to becoming a sports announcer over an unselected radio network.

- by W. F. Sherman

SCOGGIN

. . . . of Mid-Continent

Baxter I. Scoggin brings vitality and a youthful outlook to the chairmanship of this young but fast-growing Section. He was a leader in organizing this group, and during its formative period as chairman of its membership committee, he did much to put the Section on a sound basis.

Receiving his BS in chemical engineering at the University of Oklahoma in 1931, he is studying advanced business management.

His business experience has been almost entirely with the Anderson-Pritchard Oil Corp., which he joined in 1932. Beginning as a laboratory helper, he successively advanced to plant engineer, asphalt sales, and other positions until now he is the company's manager of research and development.

Long regarded as an authority on processing sour crudes, particularly those of the West Texas variety, he was active in the industry-government program for the utilization of high sulfur crudes.

- by F. E. DeVore

a military viewpoint, Capt. J. R. Tate, USN, told the NORTHERN CALIFORNIA Section April 28, when he disclosed that most Russian communities are still devastated because of the late war. From his first hand observation on a mission prior to V-J day, he reported that of the entire population of the USSR, only two or three million are members of the Communist party, and these selected people always get preferred treatment in jobs, food, and "gravy" in general. Except for the Red Army tank, mechanical products are of poor quality. The Ford plant moved to Russia went into spasmodic production of a hybrid with a 1928 or 1939 Buick body, with a Packard front end and Ford type transverse springs. Only party members and the government got the cars. All food is rationed and purchases must be made in a designated store except in a government store where eggs cost $1.75 each and bread $8.00 a loaf. Firing squads discourage black market and strikes. The iron curtain is used to prevent others from seeing how weak Russia is, and to prevent Russians knowing about the higher standard of living

CONTINUED ON PAGE 86

At Indiana Section's May 20 meeting, retiring Section Chairman William S. Powell, left, chats with President Pigott and Ray Schakel, incoming Section chairman

D. V. O'Leary explains operation of heated deicer boots to J. T. Greenlee, left, Chairman-elect H. E. Churchill, N. C. Penfold, and guest speaker Dr. J. T. Rettaliata

Col. R. S. McLaughlin, center, who joined SAE in 1909, is first to sign the register presented to Canadian Section by Col. A. S. McArthur; C. A. Chayne, left, retiring Chairman E. F. Armstrong, W. J. Davidson, and W. A. Wecker watch

C. F. Kettering illustrates a point in his talk before the Detroit Section Junior Group at their first meeting on April 20

SAE Northern California Section members try out Pan American World Airways Sleeperette seats while touring the base at Mills Field on March 24

Baltimore Section Chairman Herman Hollerith, Jr., left, SAE President Pigott, and Chief Design Engineer W. B. O'Neal of Glenn L. Martin Co. inspect a model of the Martin 2-0-2 airliner, one of the exhibits at President's Night, April 2

A group of Baltimore Section members is briefed on some of the working details of the Martin 2-0-2 during their tour of the Martin plant at Middle River, Md., on May 13

International
AIR TRANSPORT
Luncheon

August 2, 1948

Sponsored by the
Air Transport Activity, Society of Automotive Engineers

With the Cooperation of the
Air Transport Association of America,
Aircraft Industries Association of America,
American Society of Mechanical Engineers,
Institute of the Aeronautical Sciences

TIME: 12 Noon - Monday, August 2, 1948 - "Air Transport Day" at the New York International Air Exposition

PLACE: World Flight Club, New York International (Idlewild) Airport, New York City

Program

CHAIRMAN - HAROLD R. HARRIS
Vice-President and General Manager,
American Overseas Airlines

TOASTMASTER - VICE ADMIRAL EMORY S. LAND (RET.)
President, Air Transport Association of America

PRINCIPAL SPEAKER - SIR WILLIAM P. HILDRED
Director General, International Air Transport Association

The luncheon will be a feature of the nine-day "Golden Anniversary" International Air Exposition to be held at Idlewild Airport, July 31 through August 8.

GENERAL COMMITTEE

Harold R. Harris, Chairman

J. G. Borger
W. W. Davies
Charles Froesch
R. D. Speas
J. W. Thompson, ATA Representative
J. T. Geuting, Jr., AIA Representative
F. K. Teichman, ASME Representative
B. H. Horchler, IAS Representative

elsewhere, he said. Russia seeks to lower the standard of living in other nations to improve its own internal political situation, the speaker concluded.

Glenn L. Martin Co. was host to BALTIMORE Section May 13 with an inspection trip which disclosed the manufacturing procedures in building its 2-0-2 transport airplane. Chairman Herman H. Hollerith, Jr., introduced his successor, Harold Neighbors, and the new Section officers and the technical phase of the meeting was handled by W. A. Bortner, chief project engineer on the new 2-0-2.

MID-CONTINENT Section enjoyed a golf tournament and toured Woolaroc Ranch, a museum of western lore owned by Frank Phillips. "Relation Between Composition and Cetane Number of Diesel Fuel" was explained by Harold C. Smith, U. S. Bureau of Mines Experimental Station at Bartlesville. A new tool in advancing petroleum technology is the use of silica-jel for percolating hydrocarbons, he reported. Further work must be done to determine the effect of isoparafines in fuel, the author said.

Irving Chase, managing constructor of Electric Boat Co. told members of the WILLIAMSPORT Group on May 3 the development and future prospects of the PT boat. With their three engines developing 4500 hp, these fast boats had a cruising speed of 45 mph and were capable of 60 mph maximum. Time was not available to experiment with steel hulls, and the steel shortages determined the use of wood. Chase showed a film disclosing design and construction.

Speaker at NEW ENGLAND Section's April 6 meeting was Major-Gen. L. C. Craigie, USAF, who discussed "The Role of Research and Development Insuring Effective Air Power." A wartime combat commanding general and now in charge of research and development at Wright Field, he outlined the development projects under way and in prospect by the USAF. He concluded by stating that the first nation to put emphasis on research and development will be the first to accomplish the objective of producing the strongest air defense. "We must be that nation," he said in closing.

SOUTHERN NEW ENGLAND Section held its annual outing, with golf, softball, horseshoe pitching, and a dinner at Weathersfield

CONTINUED ON PAGE 88

SAE NATIONAL
WEST COAST MEETING

St. Francis Hotel
San Francisco

Aug. 18-19-20

WEDNESDAY

9:45 a.m.

City of San Francisco Welcomes SAE - Mayor Elmer E. Robinson Acknowledgment by SAE President R.J.S. Pigott

10:00 a.m.

Recent Developments in Engines and Fuels for Higher Efficiency.
-J. M. Campbell, D. F. Caris and L. L. Withrow, Research Laboratory Division, General Motors Corp.

Engine Bearing Failures
-John Stokely, California Research Corp.

(Sponsored by Fuels and Lubricants Activity)

2:00 p.m.

"Servicing the Hitch Hikers" Covering Air and Electrically Operated Equipment

Air Operated Equipment:
Air Brakes - Design and Performance, Past, Present, Future
-Stephen Johnson, Jr., Bendix Westinghouse Air Brake Co.

Heavy Electric Equipment:
-William H. Foland, Delco-Remy Division, General Motors Corp.

(Sponsored by Transportation and Maintenance Activity)

8:00 p.m.

Heavy Duty Brakes - What's New
-Ralph K. Super, Timken-Detroit Axle Co.

(Sponsored by Truck and Bus Activity

Preprints of all papers will be available at 25¢ each to members, 50¢ to nonmembers.

THURSDAY

9:30 a.m.

Diesel Engines of a High-Speed, Heavy-Duty Type for Automotive Service
-O. D. Treiber, Hercules Motor Corp.

Marine and Industrial Type Diesel Engines - Operation and Maintenance
-Hans Bohuslav, Engineering Controls, Inc.

(Sponsored by Diesel Engine Activity)

12:00 NOON LUNCHEON

Courtesy of Fruehauf Trailer Co. Admission by ticket only - Tickets received at time of registration.

Speaker: HONORABLE HERBERT B. MAW, Governor, State of UTAH

2:00 p.m.

Hydraulic Torque Converter Performance
-A. H. Deimel, Spicer Mfg. Div. of Dana Corp.

Panel: Stump the Experts - Questions on Trucks and Buses

Robert Cass, D. F. Lemaux
E. W. Dryer, R. C. Norrie
L. J. Fageol, C. A. Peirce
M. C. Horine, E. S. Ross
B. F. Jones, F. E. Sandberg
F. B. Lautzenhiser, R. B. Wuerfel

(Sponsored by Truck and Bus Activity)

8:00 p.m.

Sleeperette - The Answer to Passenger Comfort For Long Range Operation
-Robert B. Houston and John M. Parker, Pan American World Airways System

FRIDAY

9:30 a.m.

Some Further Work on High Sulphur Diesel Fuels
-Dr. L. A. Blanc, Caterpillar Tractor Co.

Performance Characteristics of Automotive Gear Lubricants
-W. B. Bassett, Lubrizol Corp.

(Sponsored by Fuels and Lubricants Activity)

12:00 NOON LUNCHEON

Courtesy of Ethyl Corporation Admission by ticket only - Tickets received at time of registration.

2:00 p.m.

Production Line Methods of Service and Repair of Heavy Duty Highway Trucks
-E. B. Ogden, Consolidated Freightways, Inc.

Tools of Tune-Up
Wallace Linville, Acelin Co.

(Sponsored by Transportation and Maintenance Activity)

6:30 p.m. COLONIAL ROOM

DINNER

R. W. Goodale,
Chairman Northern California Section
General Meetings Chairman
J. Leonard Love, Toastmaster
R.J.S. Pigott, SAE President

"MORE POWER TO YOU"
F. Glen Shoemaker
Detroit Diesel Engine Division
General Motors Corp.

Country Club May 21.

METROPOLITAN Section's 1947-48 Students Technical Paper Contest came to a close May 11 when the runners-up presented their respective papers. Winner, judges announced, was Joseph Seliber, College of the City of New York, with his paper "Pilot Injection in the High Speed Diesel. He was awarded an engraved gold watch by the Section. Runner up was Robert E. Holmgren, winner at Pratt Institute with his paper "Surging in Automobile Valve Springs;" Carl Haberman, vice-chairman for the Student Activity, presided. Titles of papers are not assigned by the Section, but left to the students with advice from the Student Branch faculty advisers. Plans will be announced early in September for the next Student Contest of the Section.

United Air Lines, Inc., was host to the CHICAGO Section Student Meeting on May 13, when nearly 400 members and students attended the inspection tour of the airline's servicing facilities, and heard a paper by Dr. J. T. Rettaliata, director, Department of Mechanical Engineering, Illinois Institute of Technology on "Jet Propulsion." As he now sees the prospects, turbojet combinations will be used in commercial aircraft within the next 10 years.

NORTHROP AERONAUTICAL INSTITUTE Student Branch went picnicking April 11 at Ladera Park. Starting off with a baseball game between second and first year men, the next event was a girls' team pitted against a men's team - a contest too confused to permit an accurate report. Various field day events whetted appetites for anal fresco put together for the SAE group by the plant cafeteria's management. Ronald Gagon, the NAI - SAE Branch vice-chairman, received a slide rule from James L. McKinley, the Institute's managing director, for topping his class.

CALTECH Student Branch sponsored a dinner meeting on April 28 for the SOUTHERN CALIFORNIA Section. The Branch members arranged a display of photographs and parts to show the complex problems faced in a jet propulsion development laboratory. A brief review of jet engineering was presented by Warren Marshall, former secretary of the Caltech SAE Branch, and the principal speaker was Dr. Howard Seifert, chief of applied physics, at the laboratory. He described the wind tunnel capable of making tests at Mach numbers 1,2, and 3.

FORD ENGINEERING SCHOOL SAE Branch made a field trip through the Ford Motor Co. Plastics Laboratory on March 22, where they examined the various processes of converting raw materials into finished products. J. K. Totten gave an informal talk on characteristics of various types of plastic material, and he emphasized the importance of styling, product engineering, chemical, production, mold designing and building divisions coordinating their ideas before any actual work is started.

Members of the SAE Student Branch of the ILLINOIS INSTITUTE OF TECHNOLOGY were addressed April 20 by Wilson P. Green, director of engine noise research at the Institute. After explaining the operation of the laboratory and the equipment used, members toured the laboratory to obtain first hand information about the work being done.

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About SAE Members

CONTINUED FROM PAGE 81

Heretofore a special engineer with Hirsch Brothers Machinery Co. in El Paso, Tex., W. M. McLAURIN recently became designing engineer for the Southwestern Engineering Co. located in Los Angeles.

Now district sales manager for the Aluminum Co. of America in St. Louis, Mo., LEWIS P. FAVORITE had been assistant district sales manager in Detroit for this company.

JOSEPH RICHTER, who had been a mechanical engineer at the USN Engineering Experiment Station at Annapolis, Md., has now become assistant project engineer, Wright Aeronautical Corp. in Wood-Ridge, N. J.

No longer in the Commercial Sales Department of the Glenn L. Martin Co., Baltimore, Md., R. WENDELL MILLER has become assistant project engineer at McDonnell Aircraft Corp., St. Louis, Mo.

L. P. McINTOSH, who has been associated with Maysteel Products,

Inc. in Mayville, Wis., is now vice-president of Paulsen Co., Inc. in Milwaukee, Wis.

RICHARD W. STEWART is now president of Willet Lumber Co. Inc., in Willet, N. Y. Prior to this post he was a sales engineer with Uplinger & Sherman, Inc., located in Syracuse, N. Y.

No longer project engineer with Bendix Products Division, South Bend, Ind., ALVIN B. COPELAND recently became eastern sales manager with Gits Brothers Mfg. Co. in Chicago.

Previously design engineer with the Commonwealth Engineering Co. in Dayton, Ohio, D. FRANKLIN BOYD is now project engineer for the Univis Lens Co., same city. He is responsible for planning, supervision and execution of special engineering projects. While a student at the University of Oklahoma, Boyd was chairman of the SAE Student Branch there.

ALEXANDER SHERMAN is now research engineer with the Taylor Forge & Pipe Works in Chicago, Ill. He was formerly connected with the Ohio State Research Foundation at Ohio State University in Columbus.

Now sales-service engineer for the National Carbon Co., Inc. in Chicago, WILLIAM VELSOR LESSELS had previously been affiliated with the New York Division of Cities Service Oil Co.

MARSHALL G. REID, who had been connected with the Mechanical Goods Division of the General Tire & Rubber Co., Wabash, Ind., recently became V-Belt Development Engineer (T-4) for the Industrial Products Division of the Firestone Tire & Rubber Co., Noblesville, Ind.

GERALD I. CLARK is now a general partner in the Clark Co. of San Bernardino, Calif. He had been chief engineer at the Woolridge Mfg. Co., Sunnyvale, Calif.

RUDOLPH E. KRUEGER now chief designer on pressurized equipment for the Pacific Airmotive Corp. in Burbank, Calif., had been chief engineer for the Accessories Mfg. and Engineering Co., South Gate, Calif., before this company was brought by Pacific Airmotive.

PAUL WILLIAMS is now vice-president of Automatic Steel Products, Inc. in Canton, Ohio.

Before joining V. P. Hunt Co. Transportation in Redlands, Calif. as superintendent of maintenance, ALVA L. DORRELL was superintendent of maintenance and transportation for the General Outdoor Advertising Co. in Chicago.

HARLAN D. FOWLER recently published a book giving a description of the flaps invented by the author. Its title is "Fowler Flaps for Airplanes - an Engineering Handbook." It covers the 31 years during which the flaps were developed, including their use in World War II. These flaps are compared with other types of flaps, such as the slotted and the double slotted. Tables, charts, and photographs are given, many of them just released by the Air Force.

HAROLD A. BACKUS, engineer and inventor of Akravue, the Commercial Third Dimensional Photographic process, has been elected president of the Backus Visuals Corp., a firm organized for the purpose of research, engineering, development, and production of Third Dimensional Photographic systems and precision photo-mechanical apparatus. They will be located in Narberth, Pa.

FRANK J. HODER, JR., has been appointed manager of Packard Motor Car Co., Marine & Industrial Engine Department. For the past six years he has been general manager and chief engineer of Marine Products Co., Detroit.

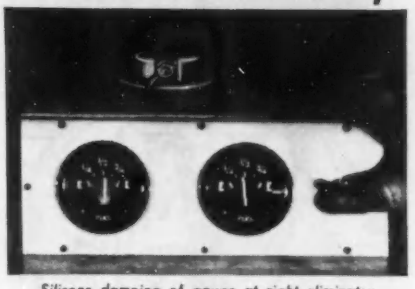
No longer assistant to the controller of Curtiss-Wright Corp., Caldwell, N.J., JESSE E. WHITE, JR., is now executive assistant to the vice-president and chief engineer of the Mack Mfg. Corp.

Recently graduated from Michigan

Silicone News

DC

Silicones Mean Stability



Silicone damping of gauge at right eliminates familiar fluttering of pointer shown in untreated automobile instrument at left.

Design frequently involves a compromise between simplicity of construction and the properties of available materials. New materials are interesting because they generally enable engineers to find more simple and therefore more efficient solutions to design problems. Damping is one of the problems that has been complicated by a lack of stability in fluids.

The instrument division of a large automotive parts manufacturer was not satisfied with the use of inertia wheels, air vanes, or magnetic damping to eliminate the fluttering of instrument pointers. Liquid damping had been considered, but all ordinary light oils or greases thinned excessively when hot or thickened and became useless when cold. More than two years ago, however, their engineers started testing some of our high viscosity silicone fluids.

Extensive road testing has proved that a fraction of a drop of our silicone fluid on the bearings performs better and is more economical than any of the more complicated mechanical damping devices. In tests conducted by aircraft manufacturers where operating conditions for instruments are even more severe, silicone fluid damping was found to be the only entirely successful method. Test performance was so completely satisfactory that the instrument division is now using our DC 200 Silicone Fluid to damp electrical instruments, speedometers, tachometers and gauges.

Among other unique and useful properties are a high degree of stability, a relatively constant viscosity over a very wide temperature range, and good lubricity between certain metal combinations. Our fluids are available in viscosities ranging from 0.65 to more than 250,000 centistokes. For more information phone our nearest branch office or write for catalog No. D 1-16

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—Chip

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State College, East Lansing, Mich., SYDNEY C. HAY, JR., has joined the Wohlert Corp., in Lansing, Mich.

LEO G. WRIGHT has been appointed assistant superintendent of the Bureau of Automotive Equipment for the City of Milwaukee. Previously to this appointment, Wright had been automotive mechanic supervisor for many years.

Previously a lubrication engineer with the Phillips Petroleum Co. in St. Louis, Mo., JACK EDWARD FLEISCHLI recently accepted the post of sales engineer for oil field and industrial equipment with the Continental Sales & Service Co. in Los Angeles, Calif.

Until recently with the Bell Aircraft Corp., Niagara Falls, N. Y. as a transmission engineer, DAVID FELD is now research technician, Glenn L. Martin Co., Inc. in Baltimore, Md.

OBITUARIES

HENRY FLOOD, JR.

Henry Flood, Jr., an authority on hydroelectric powerplant design and construction, passed away on June 17. He was 61 and was president of Flood & Watson, an engineering firm, New York City.

Flood was associated with the late William S. Murray of New York City until the latter's death in 1942. During that time he was engaged in the financing, design and construction of the dam and powerplant of the Lexington Water Power Co. on the Saluda River in South Carolina. This development contributed to the science of earthen dam construction and was the largest dam of that type in the world when constructed.

EARL F. BAKER

A veteran in the automotive business in Arlington, Mass., Earle F. Baker died suddenly on May 11. He was 59, and had lived in that city for 24 years.

DAVID PRYCE DAVIES

David Pryce Davies, who served as vice-president and consulting engineer of the J. I. Case Co., for many years, passed away on April 25.

Most of his life was devoted to the development of tractors with internal combustion engines for use in agriculture and industry. A long list of patents were issued to him in this field.

He started with the Case Co. as a machinist's apprentice as a young lad in 1886. In 1892 he assisted in building an internal combustion tractor, the first gas tractor built in this country for agricultural purposes. About 1897, he left the Case Co. for 13 years, returning in 1910 and was with that organization ever since.

Davies was perhaps the first to fully appreciate the necessity for lightness as well as ruggedness in farm tractors and to develop a complete line of such tractors. He joined the SAE in 1917.

New Members Qualified

These applicants qualified for admission to the Society between May 10, 1948 and June 10, 1948. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (Aff.) Affiliate; (SM) Service Member; (FM) Foreign Member.

British Columbia Group: H. J. Williamson (A).

Buffalo Section: Walter Crafts (M), Robert A. Schaefer (J), Charles D. Thomas (M).

Canadian Section: Vincent Leo Boland (M), Richard C. Cline (J), George Ralph Giles (A), Sidney S. Rogers (A), Clayton W. Squelch (A), William Arthur Woodcock (J), Arthur E. Woods (A).

Central Illinois Section: August A. Schmudde (J).

Chicago Section: George Hauser Amberg (J), D. E. Arnold (A), Raymond F. Christopher (A), Jack E. Cole (A), Jacob B. Courshon, Jr. (J), Irving Eugene Hand (A), R. J. Hicks (M), Richard L. Linn (A), Henry Gunther Mueller (J), John George Poulin (J).

Cincinnati Section: John S. Behne (A), William M. Seitz (M).

Cleveland Section: William P. Adams (M), Arthur P. Armington (J), Helmuth W. Engelman (M), Harold Charles Schindler (M), Robert E. Witter (A).

Colorado Group: Robert Fahl Brown (M).

Dayton Section: Morris Bean (M), C. F. Herman (A), Ralph James Hooker (M), Paul H. Mader (J).

Detroit Section: John S. Andrews (A), John Spencer Arend (A), Raymond Frank Brozek (J), Jerome S. Buzzard (J), Thomas Drexler Colbridge (M), Daniel A. Damm (M), Arthur William Edmond (M), Lewis W. Hamlin (A), Arthur N. Haskell (M), Sidney S. Hatch (M), Franklin R. Hight (M), Frank C. Holt (A), Walter E. Jominy (M), Wilson A. Jones (A), Albert T. Kelly (A), A. E. Kilpela (M), Jerry J. May (J), Arthur W. Moss (A), T. Edw. Nelson (A), Hiram R. Pacific (J), Robert A. Painter (J), Russell H. Peebles (J), Frederick A. Ringe (J), Ricklef W. Shirk (J), Burness Sprague (M) John Raymond Stair (J), Merle F. Valade (J), Louis H. Van Dike, Jr. (A), Leslie G. Wrigley (A), George C. Zerschausky (A).

Hawaii Section: Eugene L. Craig (A), August H. Reimann (A).

Metropolitan Section: Julius Agin (M), Albert A. Araneo (A), Vernon M. Babcock (M), Edward M. Bell (A), Robert M. Bram (J), Eugene P. Burden (M), Robert E. Carbauh (A), Henry John Gagen (A), Edward G. Gross (A), Stuart Phelps Hall (J), William Claude Hanway, Jr. (A), Calbe E. Hodges (J), George F. Kyber (M), William McLoof (J), Richard Edmund Robinson (J), Robert A. Sprung (A), Richard Edgar Taylor, Jr. (J), Warren Philip Westbo (J).

Milwaukee Section: Timothy Medard

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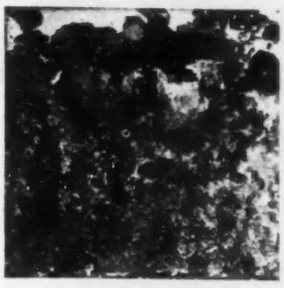

ALKALI CLEANED
500 HOURS S. S.

Comparative salt spray test on 24St aluminum. Both panels were finished with one coat of baked refrigerator white enamel. Notice that after only 500 hours the paint system on the alkali-cleaned panel is almost entirely destroyed and the aluminum itself is badly corroded. In contrast, the paint finish is still intact on the Alodized panel after 2000 hours' exposure.

ALODIZED
2000 HOURS S. S.

The Coating

"Alodine" produces a thin, tough, tight, skin-like coating firmly embedded in the aluminum. This protective skin is extremely resistant to corrosion and bonds paint firmly to the metal for the life of the finish.

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The Process

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Lawler, Jr. (M), Raymond S. Saddoris (M).

Northern California Section: Harry D. Mahr (A), W. Edgar Martin (M).

Northwest Section: Chester Drozynski (J), Louis W. Schroder (J).

Oregon Section: Lloyd T. McMahon (A).

Philadelphia Section: Stephen T. Palmer (M).

Pittsburgh Section: Earl H. Davidson (M).

St. Louis Section: F. W. Cloedy (M), Albert D. Trager (J),

Southern California Section: Lloyd B. Aschenbeck (J), James L. Mahon (M), Robert C. Weatherwax (A).

Southern New England Section: John Craig, Jr. (M), David Ramsay (A), Thomas E. Zeerip (M).

Spokane Intermountain Section: Paul S. Hindman (A).

Syracuse Section: G. James Alaback (J).

Texas Section: Wilson M. Jones (A).

Twin City Section: Charles N. Bell (M).

Virginia Section: O. L. Burnette (A), H. Y. Van Fossen (A).

Washington Section: Herbert Hewlett Howell (J).

Wichita Section: Merven E. Spencer (A).

Outside of Section Territory: Chuck Bachrach (A), Carl David Johnson, Jr. (J), Elwood F. Knapp (J), Allan Donald Shapiro (J), Bryan Hal Standley (J), John P. Townsend (J).

Foreign: William Frank Bolton (FM), Africa; F. T. H. Bradley, Major (FM), England; H. M. Meier Mattern (FM), Holland; John R. Munck (FM), Sweden; Goran E. Nordfors (FM), Sweden; Edward Victor Nurse (A), England; Everard Pantin (FM), B. W. I.; Robert Robertson (FM), England; Frank Arthur Shorten (J), England; Edward G. Sparrow (M), France; Oswaldo Fadigas Fontes Torres (J), Brazil.

Applications Received

The applications for membership received between May 10, 1948 and June 10, 1948 are listed below.

Baltimore Section: George Herbert Rice, Jr..

British Columbia Group: Joseph C. Bryant, Patrick M. Howard, Philip E. Rogers.

Canadian Section: Alexander Davidson, Frederick Krailo, Frederick James Martin, B. G. Southam.

Central Illinois Section: Arnold O. Kramer.

Chicago Section: William L. Barth, Jr., Lester L. Groce, Elmer Joseph Krueger, Russell A. Melville, Cecil Maurice Stanley, Anthony John Unruh.

Cleveland Section: Chester D. Christie, John F. Hussey, John Joseph Ivancic, Robert V. Melreit, L.L. Young.

Colorado Group: Dwight I. Binkley, T. H. Kissell, William S. Topper.

Dayton Section: Morris J. Duer, James H. Johnston, Jr., Edward Daniel McAuliffe, Marion L. Smith, Joseph S. Yasecko.

Detroit Section: Richard A. Armstrong, Jay Cee Bell, Robert O. Collins, G. V. Craighead, Samuel Brent Girdler, Jr., U. B. Grannis, Jr., Benjamin F. Hair, Edwin Francis Holly, Sheldon G. Little, Harold H. Schroeder, Koppula Subrahmanyam, R. E. Zimmermann, Jr.

Hawaii Section: Douglas C. Thomson.

Indiana Section: Thomas L. Kendall, E. W. Pummill, Phil C. Rust, Jr., Jackson Homan Teetor.

Metropolitan Section: Norman H. Collins, Joseph C. Fox, John Heineman, David L. Heller, William M. Kissam, Walter J. Milani, Brij Bhushan Rai, Robert W. Rieger, Jerome Rubler, Melvin Schwartz, John A. Scott, A. M. Setapen, James Michael Sharkey, George F. Taylor, Jr., August H. Zoll.

Mid-Continent Section: Richard K. Peppard.

Milwaukee Section: Dana J. Schneider, Robert G. Honeyager, H. D. Powell, Edwin Wyatt Walker, Troels Warming.

Western Michigan Section: Samuel Koffsky.

New England Section: John DeVincent, Harold S. Liddick, William A. Musculus, John Rosenberg.

Northern California Section: Roland T. Heyn.

Philadelphia Section: H. Preston

NOTE THESE DISTINCTIVE FEATURES

CONTINUOUS WEB. The alternated bearing surfaces for the inside and outside rims are supported by a continuous web which constitutes the spoke walls. This web gives the assembly a structure closely resembling that of a heavy girder with its strong and sturdy diagonal bracing.

UNIFORM STRESS DISTRIBUTION. The strength and stiffness of this wheel is such that the alternating stresses have little chance to develop common failures. Sudden stresses, especially characteristic of winter driving, are absorbed in the continuous web, so there is no flexing of the spoke walls. An effectively straight-line distribution of the forces from the rims to the bearings directs the stresses on the bearings uniformly, giving longer life.

FLOATING RIM BOLTS. The rim lugs are pulled down on bolts, rather than studs, to provide adaptability and uniformity of clamping — and particularly to permit quick and easy replacement. These bolts have proper clearance and are made of high-tensile steel, heavily plated to resist rusting.

SPACER. A conventional, rigid, channel-type rim spacer is furnished. This unit is strongly and accurately made to assure perfect alignment of the wheels.

GUNITE BRAKE DRUM. Drums used on Gunite Wheel assemblies are the famous Gunite Brake Drums which have established a wide acceptance in the motor transport field. These drums will provide more efficient braking, more mileage, fewer repairs, lower cost, and will eliminate drum breakage troubles.

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GUNITE WHEELS ARE CAST AND FINISHED IN GUNITE'S OWN FOUNDRIES AND MACHINE SHOPS

Albers, Max G. Fiedler, M. L. Fox, John S. Snell.

Pittsburgh Section: Hugh Conway Dorworth, Jr., D. L. Edlund, James Freeman Haley.

St. Louis Section: Robert T. Gorman.

Salt Lake Group: Eugene Morgan Hubbard, Harold C. Mallder.

Southern California Section: A.E. Bell, Henry D. Cooper, George W. McNeal, Jr., Melvin George Paul.

Syracuse Section: Owen Joseph Black.

Twin City Section: L. A. Frahs, Howard William Smith.

Virginia Section: Frank Keener.

Western Michigan Section: Anthony Lanzafame.

Wichita Section: John H. Whoolery.

Outside of Section Territory: Henry B. Brown, Richard C. Carson, Nathan Alexander Carter, Jr., Zack T. Layfield, Jr., Roy H. Liggett, Jack L. Steward, Henry Wheeler Westbrook, Jr.

Foreign: Karl Gustav Ahlen, Sweden; Harry Armitage, England; John Arthur Cooper, England; Herwald G. Devenish, Trinidad; Raimondo Gatti, Italy; Robert E. Glaenzer, France; Peter Hold, Austria; Alf Ihlen, Norway; Frederick Keith McMaster, Australia; Thomas William Poplett, England; Vernon Preston, England.

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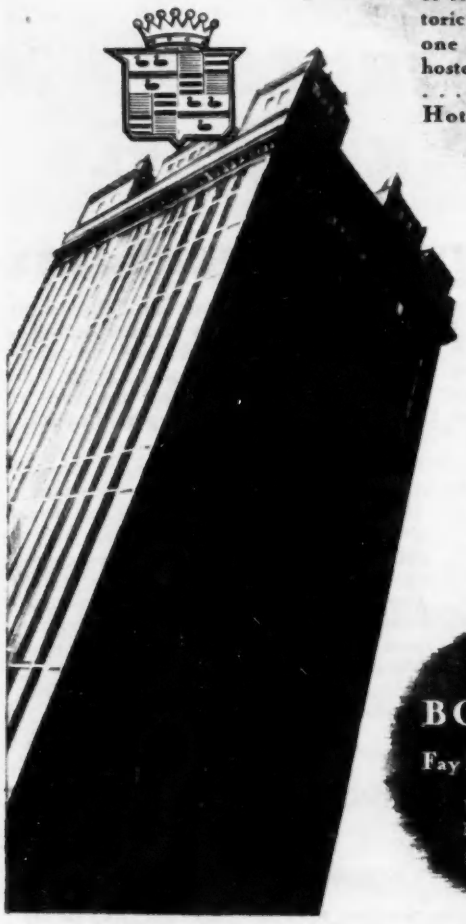

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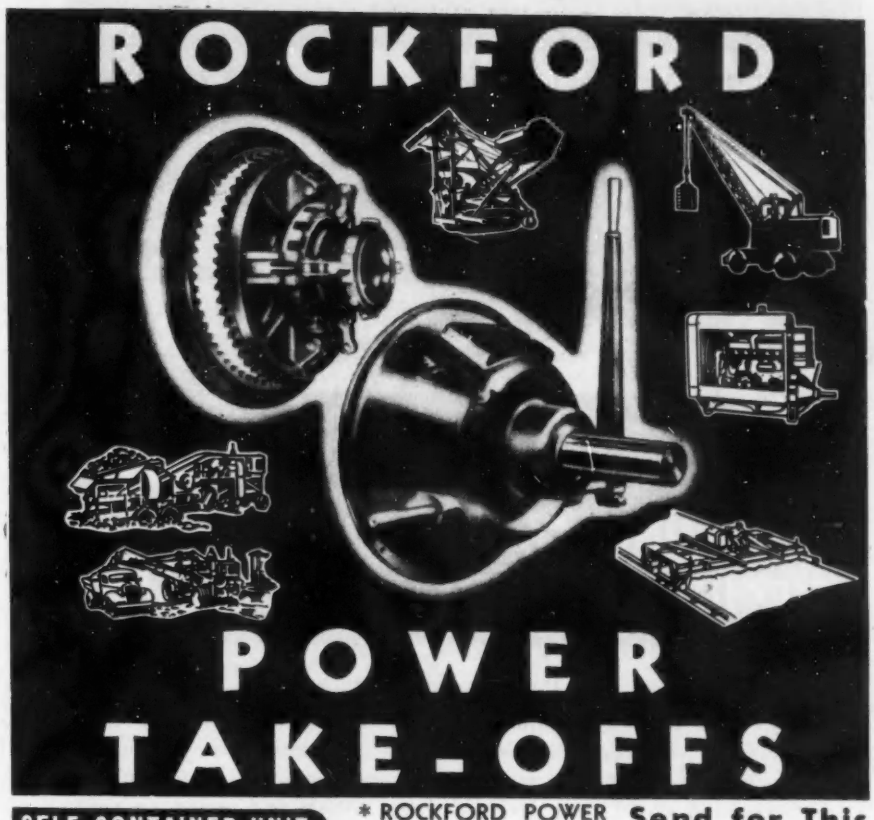

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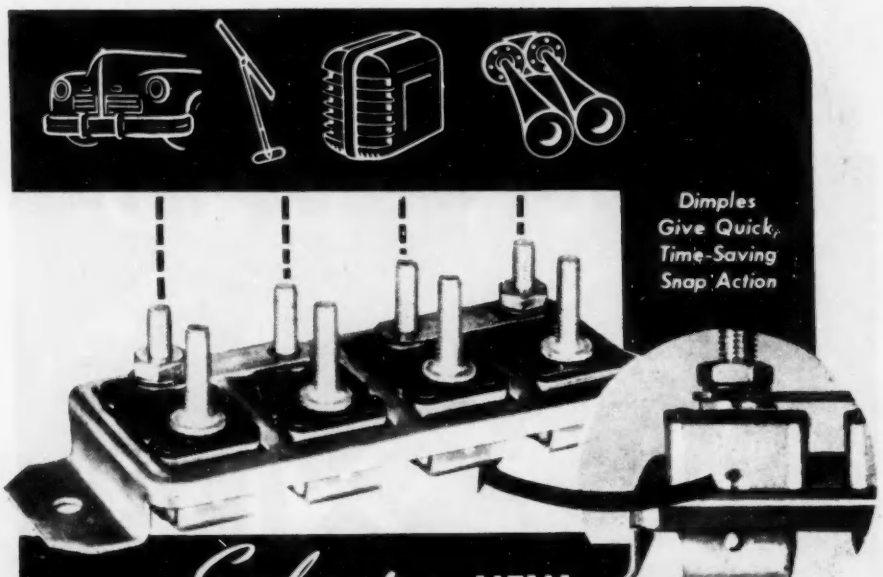

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